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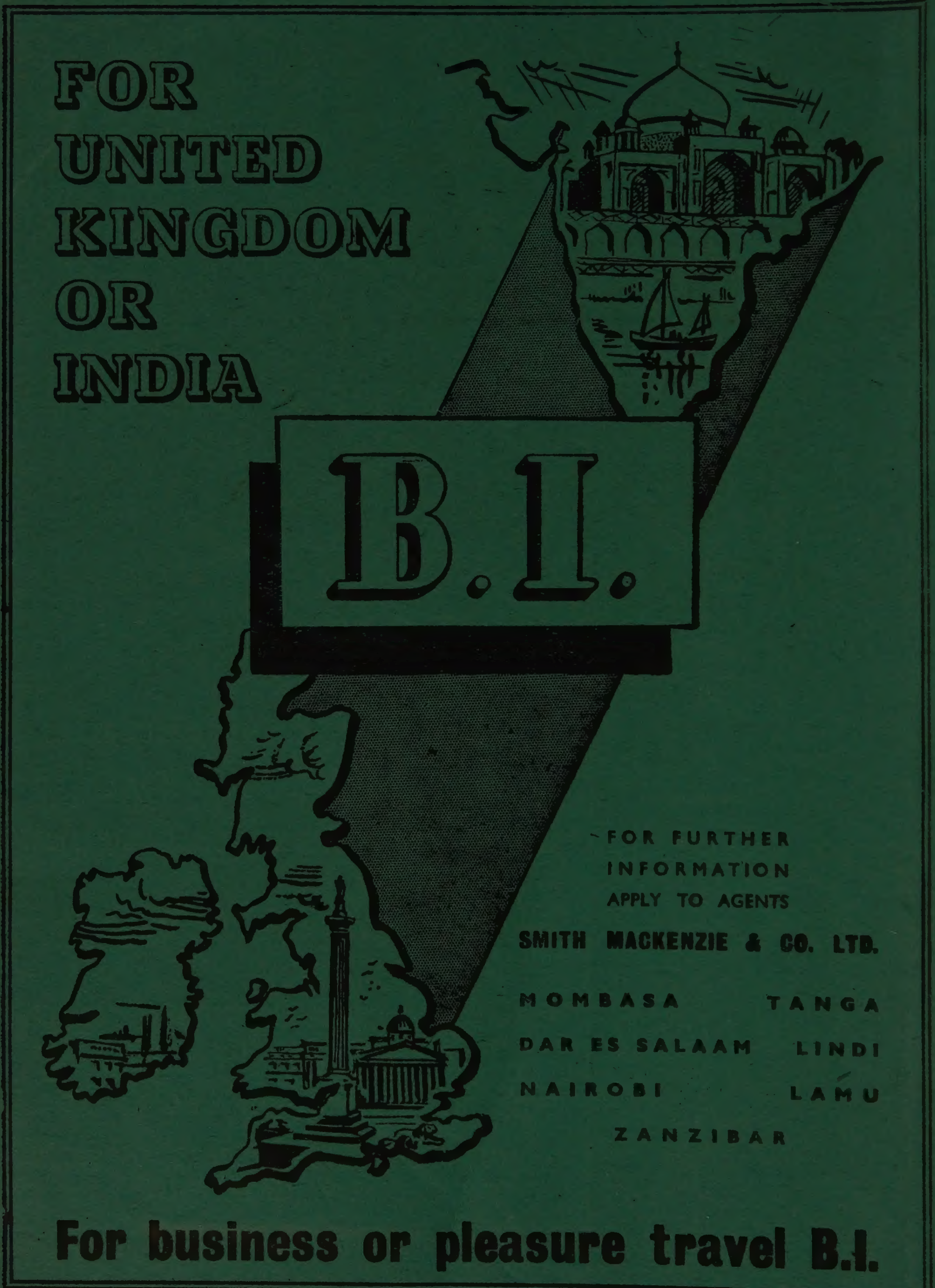

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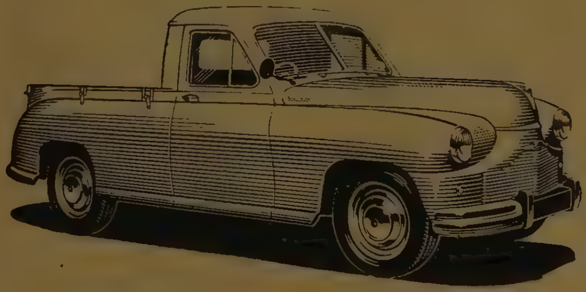

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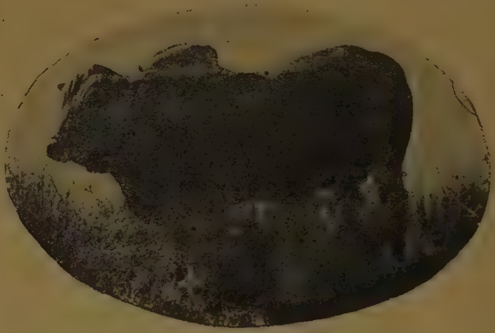

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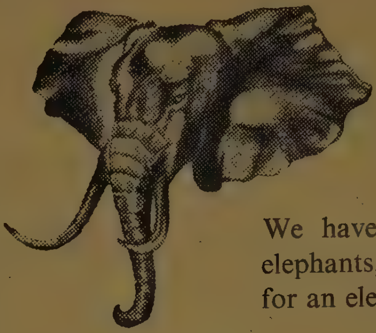

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VEGETATION AND WATER RESOURCES

The recent droughts in East Africa have focused attention on the vital importance of water in the economy of the territories, and has emphasized the need for intensive studies of the factors concerned. Deforestation is popularly believed to have a pronounced effect on water supply, and it is easy to understand that on bare soil the rain-water will run off rapidly, causing floods during rainy periods and droughts during dry spells. Ideally, all rain-water should be absorbed by the soil, supply plant and tree roots with the moisture they require, and provide a surplus which penetrates to the deep subsoil and supplies rivers and springs with a steady flow. But many factors contribute towards or against this objective, and the analysis of these is particularly difficult in Kenya, with its wide range of altitudes and climates, and results cannot be expected within a short time.

There are two complementary viewpoints in studying the water supply of a country. The hydrologist is concerned with the water resources of the area as a whole, his objective being a steady flow of water all the year round in rivers and springs and from boreholes, whereas the agriculturalist and the forester want a constant supply of soil moisture, both in topsoil and subsoil, in order that the vegetation may obtain water whenever it is needed. Both hydrologist and agriculturalist require rapid penetration of rain-water into the soil, with the minimum of run-off and surface evaporation, so that the rivers and springs may get the surplus water after trees and plants have removed what they require. It is not surprising, therefore, that hydrologists are directly concerned in the use and misuse of land, and, in fact, their work begins with the study of the vegetation of an area and its effect on water supply.

A meeting was called recently in Nairobi to correlate the work already under way on those aspects of hydrology which have a bearing on the utilization of water by vegetation.* Representatives of the Hydrological Section, Public Works Department, the Agricultural and Forest Departments, the Soil Conservation Service, the E.A. Meteorological Department, and the Agricultural and Forestry Research Organization, put forward their separate views with the common objective of finding how best the investigations could be shared between the departments, and to ensure that the best use is made of the facilities available.

For some time past the Hydrological Section, having ascertained that in most areas of Kenya practically all the rainfall is consumed by the vegetation, initiated experiments with the object of ascertaining what types of vegetation consume the least amount of water while providing adequate ground cover to prevent erosion. One of these, on a farm belonging to Mr. J. E. Kidman, at Tigoni, some 20 miles from Nairobi, has as its aim the analysis of hydrological factors in an area of 11 acres at the head of a valley, 7,000 feet above sea level, with a uniform cover of Kikuyu grass (*Pennisetum clandestinum*) which is being grazed under normal farm conditions. Rainfall, run-off, evaporation, wind and temperature records have been kept for over a year, and soil moisture fluctuations have been measured both by direct sampling and by an electrical method using gypsum blocks buried at several depths. The first year of the experiment was an abnormally dry one, but succeeding years of more average rainfall will provide valuable comparisons. Various reasons, including shortage of staff in the Hydrological Section, make it necessary for the work to be continued by the Agricultural and Forestry Departments. Consequently it has been arranged that in future the East African Agriculture and Forestry Research Organization should be directly responsible for the experiment in collaboration with the other interested departments. Soil physics studies will be extended, and emphasis will be laid on those aspects of the work which relate to agriculture and forestry.

Another experiment which was discussed at the meeting was laid down over four years ago in the Kikuyu Escarpment forest, to compare the amount of rainfall intercepted by the crowns of cypress trees and bamboo. It was described by S. H. Wimbush in this Journal, Volume 13, 1947, page 123. Two plots were selected, one in a 20-year-old plantation of Monterey cypress (*Cupressus macrocarpa*) and the other in virgin bamboo forest (*Arundinaria alpina*) on the same ridge as the cypress plot and one mile from it. Rainfall was measured in an open clearing and compared with that recorded by a number of gauges in the cypress and bamboo plots, and stem run-off was measured by a strip of lead sheeting fixed in a descending spiral round the stem of the tree and moulded to form a small gutter. The water running down the stem is caught in this guttering, the lower end of which discharges into a container.

---

* Minutes of a meeting of the Specialist Sub-committee on Water Utilization by Vegetation, E.A. Advisory Council on Agriculture, Animal Industry and Forestry, 29th November, 1949 (unpublished).

The object of this experiment is to find whether replacing bamboo with cypress would affect the hydrology of the area as a whole, since it seemed possible that the broad crowns of the cypress trees would intercept more water than the bamboos. After six months the data showed that there was, in fact, a difference in rainfall interception, cypress crowns intercepting 17.2 per cent of the total rainfall, whereas bamboo intercepted 13.4 per cent. The stem run-off was small, being 3.1 per cent in cypress and 2.5 per cent in bamboo. Other factors must be considered along with these results. since the thick spongy leaf litter under bamboo is likely to hold much of the rain-water near the surface, and the lower rate of interception by bamboo may be more than offset by lower penetration of rain-water to the subsurface layers. In order to ensure that these preliminary results did not lead to false conclusions, the experiment has been continued, and readings over a number of years may bring out fresh evidence. It should be noted, however, that these experiments do not include interception by the undergrowth.

As there is some doubt about the rate of penetration of rain-water into the subsoil under cypress and bamboo, the Hydrological Section, in collaboration with the Agricultural Department, have recently started a series of readings of soil moisture as measured by gypsum blocks buried at different depths, and by soil sampling, and the data collected over a period should answer the question. The first few readings indicated that the subsoil under bamboo is drier than that under cypress, but it is too early to draw conclusions.

Moisture changes in soils under coffee soils have been studied by the coffee research team of the Kenya Department of Agriculture, and an article in this Journal (Volume 15, No. 4, 1950) by H. C. Pereira and P. A. Jones gives a résumé of the results. Rapid penetration of rain-water and maintenance of the moisture in the surface layers can be achieved by mulching. Results so far show that coffee can dry out the soil to depths of eight feet or more in successive dry seasons, and the drying out of the first foot of soil is greatly accelerated if the soil surface is bare. This loss from an exposed soil surface has amounted on several occasions to half an inch of water from the first foot, a deficit which must be made good from the next rainfall before growth can be resumed. Experiments on the effectiveness of different thicknesses of mulch have shown that four inches of grass, sorghum or maize stover, if renewed twice a year, will completely prevent soil moisture losses by evaporation; run-off is also prevented during the heavy rains and rainfall penetration is increased. This is a great advantage to the agriculturalist, but its effect on the hydrology of the area is not fully understood. It may be that a thick mulch will retain some rain-water which would normally reach the subsurface layers and ultimately feed springs and rivers, but the agricultural advantages are so great that the planter would be unwilling to give up the extra soil moisture to the water economy of the area as a whole.

Another investigation which has a bearing on the use of water by vegetation is that being carried on by Mr. A. Walter, O.B.E., formerly Director of the East African Meteorological Service. The object of his work is to devise means for delineating agricultural zones on a basis of meteorological observations that can be easily and cheaply obtained, and accounts of the work are given in the Annual Reports of the East African Agriculture and Forestry Research Organization, 1948 and 1949. Preliminary results indicate that a measure of solar radiation may be obtained from readings of the maximum and minimum thermometers in a standard meteorological screen, and if these radiation measurements can be correlated with rainfall to give a measure of soil moisture it would be possible to obtain data from many parts of East Africa. The standard instruments for measuring solar radiation are expensive and must be operated by trained technicians, and it would be difficult to obtain data from more than a few scattered stations, If, however, the information can be derived from simple readings such as rainfall, maximum and minimum temperatures, much more information would be made available. This would lead to a means of finding the balance between evaporation and rainfall, a factor of the greatest importance in agricultural practice.

Although this wide range of work on the use of water by vegetation in relation to the water resources of the country is only in the preliminary stages, the subject is so complicated that even very tentative indications are valuable experience. In time it may be possible to draw conclusions which have an important bearing on the water economy of the region.

D.W.D.

THE CLOVE TREES OF THE SEYCHELLES*

By Frances M. L. Sheffield, Clove Research Scheme, Zanzibar

(*Received for publication on 18th May*, 1950)

When the symptoms of Sudden-death disease of cloves were being studied in Zanzibar and Pemba, a number of characters not typical of the average dicotyledon were observed. Although some of these abnormalities were of a type more usually associated with a diseased condition, they were found also in apparently healthy trees; the differences between healthy and suspect cloves being of degree only. (Sheffield, 1950.) It is highly probable that Sudden-death disease is infectious but, as yet, no diagnostic feature is known. We can only deduce that a tree is affected by the general decline in its health and its proximity to dead trees. (Nutman and Sheffield, 1949.) It is therefore impossible to say with complete certainty that any selected tree in these islands is healthy. It thus became desirable to visit some area in which cloves grow and where Sudden-death disease is unknown. The Seychelles were chosen, as being the most easily accessible from Zanzibar.

Although the main purpose of the visit was achieved, it was found that the cloves of the Seychelles islands are not strictly comparable with those of Pemba and even less with those of Zanzibar Island. To understand this, it is necessary to know something of the topography of the islands and the history of the life upon them. There are 92 islands in all, of which the 28 central ones are granitic and the rest coralline. So far as I am aware, the cloves are confined to the former group. These are thought to have formed part of a large mountainous land mass which became partially submerged by the sea during the tertiary period. The presence of coral 30 feet above sea level suggests that the sea again receded by this amount. The islands are all very small. Mahé, the largest, is about 17 miles long and 4 to 7 miles wide, having an area of 55 sq. miles but it rises to a height of 2,993 ft. The next largest is Praslin which is 6½ miles in length and 2½ miles across, its area is 15 sq. miles and it rises to 1,281 ft. The third largest, and also the steepest, is Silhouette, with an area of 7.6 sq miles and a height of 2,600 ft. The general aspect of all of them is very steep and they are all rugged with many rocky escarpments. In some places the islands rise sharply from the sea; in others they are bordered by plateaux of highly calcareous soil, which rarely reach even a ½-mile in width. (Lionnet.) No cloves are found on these plateaux but they are all confined to the laterite soils of the steep hillsides. I saw cloves on the three islands mentioned above, usually growing on steep and rugged hillsides where the trees were freely intermingled with boulders. The soils appear similar to those of Pemba and, in parts of Pemba, gradients equal to some of those the Seychelles probably occur. But the rocky formation of the ground in the Seychelles suggests that the soil must often be very shallow there. Also, the cloves seen in the Seychelles are almost invariably at far higher altitudes than are reached in either Zanzibar or Pemba, neither of which rises above 400 feet. No cloves were found on soils comparable to the sandy soils of some of the plantations of Zanzibar Island.

Although the two groups of islands lie on almost the same latitude, the climate of the Seychelles differs from that of Zanzibar and Pemba. Whereas the latter have two well marked rainy seasons, lasting from March to June and from October to December, with little rain in between, the former group of islands have rain all the year with a marked increase in amount from November to March. The total rainfall is higher in the Seychelles, averaging about 96 inches at Victoria against 60 inches in Zanzibar and 80 inches in Pemba. Both places have recently suffered a drought. In the Seychelles this has lasted for six years but the rainfall has never fallen below 70 inches per annum (above the average for Zanzibar) whilst in the Zanzibar Protectorate, where the drought lasted a year, the annual rainfall fell to half the normal and the clove trees suffered very badly. Temperature fluctuations are less at Victoria than in Zanzibar Town, the maxima being slightly lower and the minima slightly higher. Air humidity averages about six points less in Victoria than in Zanzibar. How far these figures are representative of the areas in which cloves grow, it is difficult to judge. In the Zanzibar Protectorate, they are probably fairly representative, but in the Seychelles, cloves grow at far higher altitudes than Victoria, where temperatures are taken on the pier, so temperatures might be expected to be lower. Also, some of the cloves may be constantly immersed in cloud and precipitation be far higher than the figure shown for the annual rainfall. In some clove areas, the vegetation accompanying them suggests that this is certainly the case.

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* Report on a visit to the Seychelles, 25th March to 14th April, 1950.

The Seychelles were discovered by the Portuguese but are thought to have been used by pirates some centuries before this. They were also visited by the Dutch but were uninhabited until the French occupied them in 1768, after having explored them in 1742 and taken possession in 1756. (Bradley, 1940.) At this time all the islands were probably covered with virgin forest, only small patches of which, such as some on the higher parts of Silhouette and the upper part of the Vallée de Mai in Praslin, now remain. Felling for timber began as early as 1785 and much was exported. Also, the islands have suffered badly from fire: even today, in some parts, if a man quarrels with his neighbour he may expect to find his trees fired. As a result, erosion is now a very serious problem there. Most of the original vegetation has been destroyed and many new species have been introduced. This began about 1771, when Poivre introduced spices to the islands and, during the first 35 years of this century, Dupont, then Director of Agriculture, brought in many new genera and species.

At the time of the French occupation, varieties of animal life were very few and this is still largely true. There is evidence that there were crocodiles on Mahé and that the giant land tortoise abounded there but now exists on this island only in captivity, although still wild in some other islands. Rats have been introduced and now form a major problem. There are few indigenous birds but some have been introduced. There are, however, many insects, especially scales and mealy bugs. It is thought that these came in with the many plant species imported. There is also a small black ant, *Technomyrmex albipes*, which cultivates many of them. In the early years of this century, these coccids and the "sooty mould" which follows some of them became a very serious menace to the vegetation of the islands. However, about 1936, Vesey Fitzgerald introduced the predator, *Chilcorus distigma*, which now exercises an almost complete control.

In 1771, Pierre Poivre, who planned to plant the island of Mahé with spices and to wrest from the Dutch East Indies the rich monopoly in them which they held in the markets of Europe, sent a number, including cloves, to the Seychelles. In 1780 these plantations suffered a severe reverse. War was being waged against England and to prevent them from falling into English hands, they were surrounded with inflammable materials ready to be fired. A ship flying the English flag came into the harbour (now Victoria) and it was discovered too late that she was a French slaver flying the English colours because she feared that the islands were already occupied by the English. Few trees escaped destruction. (Bradley, 1940.) Notable amongst these was the cinnamon which has been spread all over the islands by mynah birds and pigeons and the extraction of cinnamon oil now forms the second major industry of the Seychelles. Some cloves must have escaped destruction for, in a census of the resources of the Colony taken in 1803-4, 2,000 clove trees are listed. The islands were assigned to Britain in 1814. The clove was presumably cultivated for the clove of commerce throughout the century. In 1883, we read that the clove sold for Rs. 10 to Rs. 12 per 50 kg. (Bradley, 1940.) With some minor exceptions,* the export of clove buds ceased about 1898, at which time there were many large plantations of old cloves in the islands. Vanilla was then fetching good prices and the planters turned their attention to its cultivation. It would not of necessity have entailed abandoning the cloves, as in contrast to the latter vanilla is grown on the plateau land. A Seychellois, who was ten years old at the time, suggested to me several reasons for the abandonment of clove cultivation. At that time there were only a few (about 25) large land owners in the islands: they were wealthy and life was cheap and easy. As well as the high prices obtaining for vanilla, timber was being exported and also coco-nuts were coming to the fore. These are now grown all over the plateaux and also far into the hillsides and the export of copra is now by far the major industry of the Colony.

About this time must have started the distillation of oil from clove leaves. As occurred with other things, such as the giant tortoise and their timber trees, the Seychellois seemed to have used their cloves with no thought for the future. The export of clove oil rose steadily until 1925, when 3,800 kg. were exported, but after that date little or none was sent abroad. In 1930, Dupont, then Director of Agriculture, wrote " . . . many groves still survived some 20 years ago. The trees have all been exploited since then for extraction of oil from the leaves, but as they were very lofty trees, they had be cut down murderously to get at the leaves. None of them are left. The younger trees that had been planted mostly at Misère are still living but they have also been very roughly treated for the cropping of their leaves, although in some cases one part of the tree only was cropped at a time". He was not quite accurate in saying that none were left for I saw a number of trees which must have been old at the time he was writing. They were chiefly high in the mountains and possibly too difficult of access to be cropped frequently. I did see one group of trees still standing which were suffering severely from die-back or had obviously been killed by the brutal hacking they had suffered. On the other hand, I saw a number which had been reasonably cropped and, although no thought had been taken for the ultimate shape of the trees, they still appeared healthy and free from die-back. It does seem certain that this severe cropping was largely responsible for a great reduction in the number of cloves in the early part of this century.

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* I encountered only one instance of this: a planter had, until two or three years ago, exported small quantities on a small private contract. What he exported were apparently unfertilized flowers which were picked up from the ground!

At the same time, the ants, coccids and fungi mentioned above were becoming a serious problem and doubtless accounted for the loss of further trees. In 1918, four (*Lecanium tesselatum, L. mangiferæ, Aspidiotus dictyospermæ pinnulifera* and *Pseuadoonidia iota*) were described on the clove and Dupont then wrote: "The clove trees of this island are subject to somewhat heavy cropping of leaves for listillation of the essential oil. The practice of cropping is rather murderous, the upper part of the trees being cut down to reach the small twigs which are gathered for distillation. In these circumstances, the trees, especially the old trees, do not readily put forth new growth and easily succumb to bad treatment and to the four above-mentioned scale insects. The role played by the insects in question is greater than the planters generally imagine." I was told by one of the land owners that he lost many cloves due to the "black fungus" that follows the scale insects.

In the 1930's a few clove trees were planted under the reafforestation scheme in various parts of the islands. The distillation of leaves for oil still continues to a small extent but there are no exports of clove oil as such. The export of cinnamon oil, which is valued on its eugenol content, steadily rose throughout this century until in 1947 it reached 57,357 kg. Clove oil also contains considerable quantities of eugenol and the yield from the leaves is several times as great as from cinnamon leaves. Many planters distil their own oil and some now mix clove oil with cinnamon.

As a result of this wholesale destruction of the clove trees, there remain very few areas in any way comparable with the clove plantations of the Zanzibar Protectorate and many of the cloves I saw were growing in a very mixed vegetation. Further, in Zanzibar and Pemba two to four seedlings are usually planted together and all survivors are allowed to remain, so that one to four adult trees may be growing together. In Seychelles they seem usually to have been planted singly. In both places trees may have single or multiple stems.

At Sans Souci (about 500 feet above sea level*) there is a small plantation owned by the Government. It comprises about 100 trees. Because of the steep hillside and the boulders amongst which they are planted, the spacing is very erratic and never more than about ten feet. The trees are well grown and healthy in appearance and, although only 12 years old, on Zanzibar standards I would have estimated them to be about 18 years old or, on Pemba standards, about 15 years. Above La Misère, at about 2,000 feet, there is a plantation of 100 or more trees estimated to be about 100 years old. These are on both hillsides, falling away from a central ridge but they have a high closed canopy reminiscent of El Iraki in Pemba. Despite the elevation and the fact that they have been cropped for leaves, they appear very healthy, although of bad shape. About 400 feet below this on the same hill is another much younger plantation also cropped for leaves and appearing very healthy. Nearby was a third plantation where many of the trees had obviously been killed by cropping and the remainder were suffering from die-back disease.

Clove trees were also growing in the dip between two peaks at a height of about 2,000 feet on Trois Frères. They varied from 2 to 80 years and there seemed to have been two plantings, one about 80 and one about 12 years ago. They were growing in a very mixed vegetation, including: cinnamon (*Cinnamomum zeylanicum*), guava (*Psidium cattleianum*), capucin (*Northea confusa* and *N. Sechellarum*), bois rouge (*Neowormia ferruginea*), cacao (*Cacao* sp.). bois merle (*Aphloia sechellensis*), raspberry (*Rubus* sp.). Shade was very dense and that conditions were very moist was shown by the presence of large ferns, selaginellas, epiphytic ferns and mosses (even on the clove trees). Owing to the dense shade, all the cloves were dark green in colour. Except that young trees tended to be drawn up and to lose the leaves from their lower branches, all appeared very healthy.

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* As I was not able to obtain any adequate maps, the altitudes of the cloves mentioned in this report are largely guess-work and probably inaccurate.

After visting a number of groups of cloves similar to those described above, attempts were made to find cloves growing at lower altitudes and, if possible, on sandy soil comparable to that of some of the plantations of Zanzibar Island. A single tree was found at 30 feet above sea level and, some miles away, a group of about six at 20 feet up. These were growing in a clay soil but it had not got the red colour characteristic of the soil of the hillsides of the Seychelles. These trees did not appear quite so healthy as those of the higher slopes but it was difficult to judge as they were few in number, had been cropped, and were mixed with other trees.

All the districts so far described are in the Island of Mahé. Visits were paid to two other islands to see clove trees. On the N.W. side of Silhouette Island a group of cloves was growing in an exceedingly steep and rocky valley from about 1,000 to 1,200 feet up. Climatic conditions were probably intermediate between those of La Misère and Trois Frères. The owner considered that they had been carried there by birds but this seemed unlikely as they were mixed with far fewer trees of other species than were usually seen. They were of all ages from seedlings of a few months to trees of about 80 years. It seemed more probable that there had once been a plantation there which had been neglected and all naturally sown seedlings allowed to grow. On the edges, the cloves were mixed with other trees and also with "bracken" (*Gleichenia dichotoma*). They appeared very healthy and were of good shape. Probably owing to the extreme difficulty of access they had not been cropped for leaves.

In 1930, Dupont wrote: "Cloves grow slowly in Mahé, but make better growth in Praslin which is drier." A visit was therefore paid to Praslin and I found I could not entirely agree with this statement. It was, of course, impossible to judge the speed of growth, but those I saw, some two to three dozen of various ages about 200 to 300 feet up the Vallée de Mai, were good but no better than many I saw in Mahé. The rainfall recorded for Praslin is about 20 inches less than that of Victoria but, in these islands, rainfall may be very local and it seemed probable that the Vallée de Mai has more than the amount recorded for Praslin. That the upper parts of the valley are very moist is obvious from the vegetation which is practically untouched primeval forest and which consists almost entirely of Coco-de-mer, Pandanus, palms and large ferns and various epiphytes.

In Zanzibar we have found that, for most of the year, the absorbing roots are very fine but may thicken up towards the end of the cool dry season (i.e. in September). Roots from several trees of each of about ten areas in the Seychelles were examined. Without exception, the absorbing tips were even finer than those of the Zanzibar cloves. This is possibly due to the wetter climate of the former. Whether or not there is a seasonal effect in the Seychelles I was unable to discover.

I saw very few flowers on the trees and they seemed to flower very erratically. When present, all stages from very young buds to almost ripe fruit were found on the same tree. Dupont also observed this and wrote: "The tree is better adapted to the manufacture of leaf oil than to production of cloves, as it flowers very irregularly in the Colony."

Apart from scale insects and mealy-bugs, which have been brought very largely under control, Melitoma and Rhinoceros beetles of coco-nuts and some cassava mosaic, the vegetation of the Seychelles seems extraordinarily free from disease. It is true of the clove. I found a small amount of the red-spotting of the leaves, which is thought to be due to the alga *Cephaleura*, there is no Sudden-death and die-back is present only in trees which have been cruelly cropped for leaves. Several species of coccid were found on the cloves cultivated by a small black ant but never in sufficient quantities to form a serious menace. The *maji-ya-moto* ant, *Oecophylla longinoda*, which is such a serious pest in Zanzibar and Pemba, was not found nor was the scale insect, *Saissetia* sp., which it normally cultivates. (Nutman and Sheffield, 1949.) With the exception of these two, the Zanzibar cloves are extraordinarily free from insects. We have suggested that this is because only insects tolerated or cultivated by the ant can survive but the alternative suggestion has been made that the clove oil is a deterrent. The fact that a number of species are present on Seychelles cloves and that, in the past, they were sufficient in quantity to kill the trees, suggests the former explanation to be the true one.

With the exception of those which had been unreasonably cropped for leaves, all the clove trees I saw in the Seychelles were exceptionally well grown and healthy in appearance and compare very favourably with even the best of the Zanzibar Protectorate. There is, however, a possibility that some of the differences noted are due to genetic causes, as there seems some doubt as to origin of the cloves of either locality. Dupont stated that the cloves of the Seychelles were "considered to have the Penang character according to the authorities of the Imperial Institute" but those of Zanzibar almost certainly differ genetically from those of Penang. That the clove does well in the Seychelles is without doubt. Dupont said that "the soil, though poor, is good for that spice plant and its culture should not be abandoned, as there are few countries in the world where it has succeeded". Sumner Gibson also reported that in these islands it "grows well at elevations of 1,000 to 1,500 feet".

There seems little prospect of its cultivation being again undertaken on any scale, the Seychellois seem always to choose those exports which will give a good return for very little effort and with very little thought for the future of their land. This is evidenced by the way they exploited their indigenous timber trees until hardly any remain, by the increasing production of copra, by their exploitation, even to the detriment of these shrubs, of the cinnamon so fortunately spread by birds. At present, patchouli promises good returns and large areas are being planted with it. The Department of Agriculture has, very rightly, two major concerns: one is to combat soil erosion by reafforestation and by terracing and the second to make the islands self-supporting in foodstuffs. This they aim to do by encouraging the growing of more vegetables and fruit and by improving and increasing livestock.

The main purpose of this visit was to find out whether certain characters of the clove, which are not typical of dicotyledons as a whole, but which are found in both Sudden-death suspect trees and in trees diagnosed as healthy in Zanzibar, are in fact peculiarities of the clove or whether they are due to incipient infections with Sudden-death disease. (Sheffield, 1950.)

The only symptom of this type visible microscopically is a mottle which appears at one stage in the development of the leaves. This is invariably present in the Seychelles cloves. In trees, such as those at Sans Souci, which are exposed to full sunlight and whose leaves consequently always remain yellowish, it is particularly conspicuous. In the many trees seen growing in more or less forest conditions, the leaves are shaded and therefore early assume a dark green colour. In these, although not so obvious, it can always be found.

Of the anatomical peculiarities, all were found. There is secondary thickening in the internal phlœm and necrosis occurs in both internal and external phlœm. The cambium is very narrow and delicate and the xylem is very unevenly thickened and lignified, whilst there is an enormous development of lignified mechanical cells in other tissues. Tannins, oil and calcium oxalate are produced in abundance. In the Zanzibar cloves, starch reserves are small and I had the impression that they were rather greater in the Seychelles cloves, but this requires further investigation. Tyloses, which both Campbell (1940) and Heim and Bouriquet (1937, 1938) had thought to be due to a diseased condition, are often found. I had found a certain discoloration of the phlœm of the root to be diagnosttic of Sudden-death disease in certain areas with a sandy soil in Zanzibar but to be present in all plants growing on a red clay soil. In Seychelles, no trees could be found on sandy soil but roots were examined from several trees from each of ten different areas and the discoloration was always present. Bodies morphologically similar to those caused by some viruses but differing from them chemically were found in Zanzibar cloves. These were always present in the leaves of each of several trees from ten different areas in the Seychelles. It is therefore evident that none of the characters we have yet observed in the clove can be regarded as diagnostic of Sudden-death disease.

Apart from the conclusions which have been reached with regard to Sudden-death disease, there are two suggestions which might be offered as a result of observation and information obtained in the Seychelles.

I have often wondered why the clove wood is not used as timber in Zanzibar. On inquiry of a carpenter, I was told that it is too hard to work without machinery. It has apparently been used both in house-building and for making furniture in the Seychelles where no machinery is available. In view of the facts that timber has to be imported into Zanzibar and large quantities of clove wood are unfortunately continually becoming available, the possibility of its use might be investigated.

The clove trees of Zanzibar become very lofty and difficult to crop but it is generally held that pruning would cause their death. In the Seychelles, the trees are cropped for leaves. The more reasonable growers remove only about one-third of the tree each year and the trees remain healthy but become a very bad shape presumably because the branches taken are those most easily reached. This, however, does seem to prove that pruning should not kill the trees. Experiments have been carried out in Zanzibar but only using very young trees. Some further experiments using older trees might be carried out with, of course, due precautions to prevent the entry of fungi into the cut branches.

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BOOK REVIEW

SOVIET GENETICS AND WORLD SCIENCE, J. S. Huxley, M.A., D.Sc., F.R.S., Chatto and Windus, London, 1949.

I read Professor Huxley's small but weighty volume with a feeling that he had to a considerable extent wasted his time. Lysenko is not an opponent worthy of Huxley's guns, and Huxley has brought the whole weight of his great intellectual armament to bear upon him. How much more usefully it would have been employed had he ignored Lysenko and given us a straight discussion of authority and freedom in the scientific life of the western world!

Huxley disposes of Lysenko in a single paragraph of his preface which is worth quoting:—

> "I at first imagined that there must be something in Lysenko's claims. However, the more I heard and read, the clearer it became that Lysenko and his followers are not scientific in any proper sense of the word—they do not adhere to recognized scientific method, or employ normal scientific precautions, or publish their results in a way which renders their scientific evaluation possible. They move in a different world of ideas from that of professional scientists, and do not carry on discussion in a scientific way. Michurinism, as their form of genetics is called, is largely based on ancient superstitions which the advance of scientific knowledge has left behind; in any event, it is less a branch of science comprising a basis of facts, than a branch of ideology, a doctrine which it is sought to impose upon facts."

Why should it be necessary after that to write another book to confound him? Lysenko has been dealt with faithfully by a number of other authors, and there is adequate evidence in their writings that Michurinism is "not scientific in any proper sense of the word". Huxley's contribution, as I see it, is his discussion of the reasons why we in the western world prefer science to ideology. And I think he would have made a landmark in the history of science if he had taken this as his subject without more than passing reference to the ideology that flourishes under the shelter of the iron curtain.

J. B. H.

AMERICAN "KNOW-HOW" AND KENYA–UGANDA FARMING

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The object of my very brief visit to East Africa in 1948 was to compare Kenya and Uganda with the South-eastern United States and try and make up my mind which kinds of "know-how" could usefully be exported from the United States to East Africa and, equally important, which kinds should be avoided.

"Know-how" may be defined as the art of converting scientific and technical knowledge into cash or better standards of living. "Know-how" brought in from other countries can cut a lot of corners. If applied at the right time and place it can be a profitable substitute for scientific knowledge or at least a useful supplement to local knowledge. But misapplied "know-how" can be a most expensive import.

This article therefore falls into two parts. First, a brief comparison of Kenya-Uganda with the South-eastern U.S.A. and, secondly, a tentative attempt to list those kinds of "know-how" which are and those which are not worth importing from the United States.

Comparison of Kenya-Uganda with North America

At first sight there appear to be many similarities between the Kenya-Uganda region and that part of the North American Continent with which it is most comparable, viz. the "old slave" south-east and Deep South (North and South Carolina, Tennessee, Kentucky, Georgia, Alabama, Mississippi, Louisiana). Both regions show a wide range of "near" tropical ecological types and farming types; both grow a broadly comparable range of crops; both have a large indigenous or derived African population with an upper social strata of European origin. But such resemblances are, if not superficial, at least apt to be dangerously deceiving.

Climate, Soils, Vegetation.

The whole of the U.S.A. is north of the Tropic of Cancer and mostly falls within latitudes N. 35° and N. 45°. Kenya and Uganda on the other hand lie astride the Equator. However, except for the coastal belt near Mombasa the altitude of most of Kenya–Uganda is over 3,000 feet, and at places in the White (European) Highlands land is farmed at 10,000 feet. Hence annual average temperatures, even in the warmer sections, do not exceed 70° F. and an annual mean of 60° F. is common in the Highlands where most of the European farms and plantations are found. In practice, therefore, average temperatures in Kenya–Uganda are about the same as those in the southern U.S.

The mean rainfall in East Africa naturally varies considerably by reason of the mountainous nature of the country, but except for the Kenya (Northern Frontier) Desert runs between 30 in. and 60 in. or more. By North American standards, therefore, Kenya–Uganda appears humid. However, the evaporation is almost certainly higher and more constant from month to month than in the south-east of the U.S.A., which has a similar range of precipitation. Thus, though I could get no figures to prove it, "precipitation efficiency" is probably lower in Kenya–Uganda than in the south-east of the U.S.A. For instance, in the former serious soil moisture deficiencies occur seasonally in districts with 35 in. to 50 in. rainfall, whilst in some areas with nearly 50 in. of annual rainfall "dry farming" was almost necessary.

The equatorial location of Kenya–Uganda and its proximity to the Indian Ocean, Victoria Nyanza and other great lakes substantially moderate the climate. Thus, there are few seasonal changes in temperature and, though there are two post-equinoctial peaks of rainfall (April–May and October–November), there is usually some rain in most months. Further from the Equator one moves into the summer rain—winter drought type of climate, i.e. to regions where the soil is most exposed to erosion at the time of year when there is least rain. In the south-eastern States, on the other hand, there is a pronounced hot and cold season and good rainfall in the summer six months (April–September).

Frosts are practically unknown in Kenya–Uganda except, of course, at high altitudes, but Key West (at the extreme southern tip of Florida) is the only completely frost-free area in the U.S.A. Most of the south-eastern States have frost-free growing periods of from 250 to 350 days. The winter is cold enough to check most plant growth but not hard enough to have a protective covering of snow and ice. One effect of this is that in winter a high proportion of the soil in the south-eastern States is bare and exposed to the heavy winter rains; much of it is then subject to severe erosion unless it is put down to grass or winter cover crops.

Rainfall intensity is also high in both countries; the maximum U.S. precipitations of 3 in. to 4 in. in one hour are not, apparently, uncommon in Kenya–Uganda. This means that, as both regions are hilly and carry large acreages of row crops, water erosion is a serious problem common to both. Finally, relative humidity tends to be high in both Kenya–Uganda and the south-eastern States where the annual (8 a.m. and 8 p.m.) average is over 85 per cent.

To summarize, the climate in Kenya–Uganda at, say, 3,000 feet, is an eternal Washington, D.C., June (with somewhat cooler nights) and in the higher section of the White Highlands is like an unending English June. By contrast the summer climate of the Cotton Belt is not unlike that of Kenya–Uganda during the post-equinoctial peaks of rainfall. Its winter climate is more like that of a rather cool summer in the North of Scotland, e.g. rye grass and oat pastures are important sources of winter grazing on the better farms in the south-east. The relative monotony of Kenya–Uganda climate contrasts with the marked seasonal temperature changes in the U.S. This factor may well enhance the vigour of the population of the south-eastern States—for variety in climate is held by some authorities to be an effective work stimulus.

These major climatic differences are also, of course, reflected in the indigenous vegetation. In Kenya–Uganda the original cover is, or was, mainly light semi-deciduous tropical forest or thorn forest or savannah; in the south-east of the United States it was, or is, middle latitude broad-leaf forest or coniferous forest or mixtures thereof.

Soils.

I did not have time to inquire about Kenya–Uganda soil types which, as one would expect in a region of such varied climates and topography, showed a considerable range. However, the general impression left in my mind was of lateritic types. To this extent they are like the soils of the South-eastern U.S., which are mainly red or yellow podsols of lateritic type, excepting the peaty soils of the Gulf Coast and Florida and excepting the alluvial soils of the Lower Mississippi and its delta. (A description of the soils of the U.S. may be found in "Soils and Men: U.S. Department of Agriculture Yearbook of Agriculture, 1938".)

Even, however, if the soils are very broadly similar in grouping there is one important difference. Much of the Southern U.S. topsoil has been washed away. What remains has been considerably exhausted by continuous cropping. Some fields are alleged to have grown nothing but cotton for a hundred years and only continue to yield because, like most crops in the South, they are heavily dressed with fertilizers. This heavy use of fertilizers in the U.S. contrasts vividly with the almost complete absence of fertilizers in Kenya–Uganda.

Crops.

In the south-east of U.S.A. cotton, in spite of a 50 per cent decrease in acreage over the last 30 years, is still the main cash crop. Maize is the main subsistence and fodder crop. Livestock, peanuts, peaches and other crops, although increasing fairly rapidly, provide only a small part of the farm income. Farming is commonly carried on in small units by share-cropping tenants; mechanization has not yet developed very far; and in general the standard of living is lower than in most other parts of the U.S.

There are, however, various "special crop" areas in the coastal regions and in the Mississippi delta, e.g. citrus fruits and winter vegetables in Florida, sugar cane and rice in Louisiana, rice and vegetables in Texas, rice in Arkansas, tobacco in North Carolina, Kentucky, Virginia and Maryland.

In the Southern U.S. diversification of the farming, thus reducing dependence on cotton and maize, is being encouraged with some success. It would seem, however, that an increase in the size of the present small farming units will have to come about before southern farming can take full advantage of modern techniques and provide a reasonable standard of living for its operators.

The peculiarities and wide range of the climates of Kenya–Uganda and the presence of advanced European commercial farms next door to regions of primitive native subsistence agriculture make it difficult to generalize about cropping systems in Kenya–Uganda, even where any system can be said to exist. The principal subsistence crops are maize and sorghums, but wheat, bananas, cassava, yams and the various legumes are extensively grown. The major commercial export crops are coffee, tea, sisal, cane sugar, cotton and pyrethrum.

Livestock.

No one would claim that the livestock industry in Kenya–Uganda is highly developed. With better systems of management the livestock population, even on native reserves which are now overstocked, could no doubt be increased, but at present it is hardly as important as livestock in the south-east of U.S.

In this latter region, though livestock is steadily increasing, there are still relatively few farms dominated by livestock or where the farming system is mainly designed, as it is in part of the Middle West and north-east of the U.S., to provide concentrates, grazing and coarse fodder for cattle, pigs and/or poultry. On the other hand, most southern farms have a few cattle or pigs and poultry and in some parts mixed cotton and livestock farming is now markedly in evidence.

Land Tenure.

Except in the special area of Buganda there is in Kenya–Uganda nothing comparable to the American owner-occupied family farm or even to its poor relation, the share-cropping farm. Most Africans hold their land from their tribe on various types of life or family tenancies. The farms operated by Europeans and other non-Africans are either held on long leases from the Crown or owned outright and are largely worked by hired or squatter African labour.

Before the Civil War (1861–64) there were in the south-eastern States some family farms, operated by men whose descendants have now in some cases become "poor whites", but this region was dominated in general by the large plantations owned and managed by whites and based on the labour of negro slaves. The latter, however, were often treated as, and felt themselves to be, faithful "family retainers". With the abolition of slavery in 1865 these plantations were largely broken up into smaller holdings and are now worked on the share-cropping system. Under this system the landlord provides the land, the house and sometimes the draught power and implements; the cropper and his family, whether white or coloured, provide the labour. The saleable output is generally split 50:50 between landlord and cropper who may also split the cost of seed and fertilizer between them. The length of such tenancies is short, probably only four to five years on the average.

Social and Political Background.

The residuum of the old white plantation aristocracy persists in the south of the U.S. and still has considerable political power. Many of these "Southern gentlemen" like some of the European settlers in Kenya attempt to perpetuate that "gracious living" which is so difficult to achieve in the world to-day. (I have never, however, seen "polo sticks" on sale in a farmers' co-operative store in any part of the States.) Their attitude to life, which is shared by traders, officials and professional men, contrasts vividly with the rush and bustle of the industrial North. In this Southern society, the negro, in spite of his nominal enfranchisement, enjoys little political influence and somewhat limited social amenities.

The south-eastern States were originally thinly peopled by North American Indians who were driven out or "liquidated" as the Europeans, from the early 17th century onwards, penetrated the hinterland. Subsequently the latter brought in negro slaves who were largely of West African origin. This negro population of the U.S. has been in close contact with the white man for at least 150 years (as against 50 or less in Kenya–Uganda) and it is said that half the so-called "negro" population of the U.S. has some European blood in its veins.

American negroes seem, at present, more amenable to technical progress than the indigenous Africans of Kenya-Uganda, who are mainly of "Bantu" type and are increasing fairly rapidly in numbers. Further, the American negro has, of course, been detribalized for at least a century. The East African is still mainly in the tribal or semi-tribal stage.

Administrative Systems.

The Kenya–Uganda Governments, with their overall supervision by the metropolitan power, have no direct parallels in the U.S.A., where the State Governments have, as part of the federation of United States, nominal control over almost all their domestic matters. The U.S. Federal Government, through its money power and its constitutional functions in respect, e.g. of inter-state trade, has, however, considerable influence, and many of the agricultural officials, extension and research men working in individual States are, directly or indirectly, under Federal control.

This system of dual control, aided by the American belief in the virtues of competition, does, however, result in what to us appears as untidiness and overlap in agricultural administration. Thus, the advice given to a U.S. farmer by his County Extension (Advisory) Agent, who is employed by the local State, may conflict with that of the Federal Soil Conservation Service man even though their offices are within a stone's throw of each other in a small country town. Nowhere in the U.S. are the services which concern the farm (viz. agriculture, animal health, human health, education, roads, etc.) co-ordinated locally as they are by the District and Provincial Officers in Kenya–Uganda.

Thus, Kenya–Uganda have in general little positive to learn from U.S.A. about rural administration or the administrative side of such field services as soil conservation and extension (advisory) work.

Rural Standards of Living.

Perhaps I may conclude this brief comparison of climatic, farming, social and administrative factors by an attempt to compare the standards of living. This is always a difficult and often a dangerous thing to do. I got the impression, however, that the typical European farmer was about as well off as his opposite number in the U.S. The African's standard of living is, however, markedly lower than that of the American negroes and inevitably prompted the question: Why is the average income of a negro family on the poorer farms in Mississippi (where half the population is coloured and which is the poorest State in the U.S.) probably five to ten times that of the East African farm family?

The answer seems to be that the American negro has been detribalized and subject to white influence for 100 years more than the East African. He has become to some extent socially and even genetically assimilated by the white man's civilization and ways of earning a living. Removed from his original West African context he seems more amenable to European modes of living, thinking and working. The American negro also, of course, has larger farms and greater material resources than the typical East African. But this, it seems, is not because the African has in general fewer resources at his disposal. It is rather because the means of developing them and of acquiring the education, health and energy needed to raise his standard of living are only now becoming available.

In the 19th century the physical sciences made it possible to open up North America and to bring the American negro up to his present standard of living. My impression was that in the 20th and 21st centuries this standard of living could also be the East African's. The physical, medical and agricultural sciences and "know-how" of the European are, as it were, trying to get their feet across the threshold of the African's hut. The main problem of East Africa is the African himself. This, of course, is no new conclusion. It is the daily care of the settler, official, trader and missionary.

IMPORTS OF AMERICAN "KNOW-HOW"

Two broad conclusions emerge from the first part of this article. The first is that despite superficial resemblances there are in fact considerable differences in climate and vegetation and in farming and administrative systems between Kenya–Uganda and the south-eastern States of the U.S. The second is that there are even bigger differences between the detribalized American negro with a relatively high standard of living and the tribal or semi-tribal East African.

If these conclusions are agreed then they do imply that American "know-how", despite the standard of living associated with it in the U.S., has only limited direct application in East Africa. In other words, just as British science has probably proved more useful in East Africa than British farm practice, so American scientific knowledge is likely to be more useful than "know-how" as such. Thus, as far as East Africa is concerned the problem is not primarily one of importing American "know-how". On the contrary, it is rather one of using U.S. scientific achievements in such fields as the classification of tropical soils, the breeding of rice, sorghums, sweet potatoes, cotton and sugar cane, the development of heat-tolerant breeds of cattle and then converting this knowledge on the spot to East African "know-how".

Low Priority Imports.

First let us see what kind of "know-how" should not, or at least need not, at present be imported. Here are my suggestions:—

(*a*) *Administration and Organization.*—In general the Kenya–Uganda systems are better co-ordinated, provide better service to the farmer and have little to learn from the U.S.

(*b*) *Marketing Processes and Price Stabilization Techniques.*—There is little to learn from U.S. that cannot be learnt locally or from the U.K.

(*c*) *Pests and Diseases.*—Generally speaking the entomologists, veterinary surgeons and other research men in Kenya–Uganda are adequately in touch with their U.S. opposite numbers, so little additional action is needed to keep them up to date on U.S. "know-how" in these fields.

(*d*) *Heavy Machinery.*—In the U.S. the combination of plentiful steel, cheap fuel and high labour costs encourage a certain profligacy in the use of heavy farm equipment. An impression has gone round the world and taken root in East Africa and elsewhere that large U.S. crawler tractors and heavy earth-moving machines are essential for soil conservation and irrigation works and even for ploughing land which has become too consolidated. This is only partially true, and in Kenya–Uganda where steel and fuel are costly and labour (albeit not very efficient) is cheap British medium and small-size tractors (with equipment to match) should not only be equal to most jobs but cheaper to run and less drain on limited dollar resources.

(*e*) *Livestock.*—Production conditions for milk, pigs and poultry are so different in the U.S. that there is little U.S. "know-how" of use to Kenya–Uganda. However, recent American experiments in breeding of livestock for and their management in hot climates may be worth watching.

(*f*) *Fertilizers and Pesticides.*—Although fertilizer usage will no doubt increase in Kenya–Uganda the differences in cropping systems, soils, rates of application, supplies, etc., are so great that American "know-how" probably means little in East Africa. The same is probably true for the newer pesticides, many of which would be dangerous in native hands—some of them, such as D.D.T. and parathion, which are being used freely rather than wisely in the U.S.A. are already proving quite dangerous enough in American hands. By the same token U.S. "know-how" on spraying and dusting machinery would not be of much use to Kenya–Uganda.

Soil and Water Management.

On the positive side there seems to be two very important and closely related fields where U.S. "know-how" might be worth importing into Kenya–Uganda, viz. soil management and water management. Although the Americans are probably not ahead of East Africa in the use of cover crops, of natural regenerative and of other biological methods of soil conservation they have plenty of "know-how" about physical methods (e.g. terracing) and some of their simpler machines and techniques (e.g. the whirlwind terracer) are well worth studying.

In the effective use of semi-arid land the Americans are probably as up to date as anyone. The rapid expansion of "ploughless "stubble-mulch" farming in the U.S. wheat belt and the problems of range management on overgrazed lands are two subjects where U.S. "know-how" might be useful to Kenya–Uganda.

Americans and Canadians have considerable experience in impounding run-off water for stock watering and irrigation purposes and for checking water erosion. In this field, as well as in another device which should have considerable possibilities in Kenya–Uganda, i.e. overhead or sprinkler irrigation, North America has much useful "know-how".

Crops for Seed.

Finally, we come to cash and forage crops and grasses. The Kenya–Uganda area is so diverse within itself that one is inclined to overlook its rare combination of (i) uniform day length throughout the year, (ii) moderate and monotonous temperatures, and (iii) a highly seasonal rainfall instead of the uniformly distributed precipitation one expects to find on the Equator. To me, therefore, the surprising thing was not that improved American varieties of soya beans or hybrid maize or linseed failed when tried in Kenya–Uganda; it was that cotton, coffee, maize, wheat and other crops from non-Equatorial latitudes should thrive at all. The average yields of these crops, all of which depend on seeding or fruiting, is not, however, high by the standards of south-east U.S.A., where yields are themselves low compared to the better parts of North America or to Western Europe.

This is not to imply that the wrong crops are being grown in Kenya–Uganda—the man on the spot has had to learn the hard way which are the most suitable. It does suggest to me, however, that the final product of the American plant-breeders' "know-how", viz. improved new varieties particularly adapted to specific ecological conditions in various parts of south-east U.S.A. are unlikely to succeed in Kenya–Uganda. Forty or fifty years ago when established varieties had not been "custom tailored" to meet local requirements it was possible, for instance, to find a Middle Eastern or Caucasian wheat like Turkey which did relatively well in the Great Plains of the U.S.A.

But as the plant breeder pays more attention to local conditions of soil, water, disease, markets, so improved varieties tend it seems to have less general application. The genes became, as it were, over specialized. It seems to me, therefore, that U.S., or for that matter any other imported varieties of crops which are harvested as seeds or fruits, will become progressively less suited to Kenya–Uganda or to other areas. This means that each region of the world is likely in future to have to do more of its own plant breeding and more careful pre-testing of introduced varieties. This would be particularly true of Kenya–Uganda with its peculiar "tepid" Equatorial climate and marked seasonal rainfall peaks.

These views are, I recognize, somewhat unorthodox and are not accepted by some experts who know much more about plant introduction than I do. Nevertheless, I put them forward for consideration.

Vegetative Crops and Grasses.

When, however, one considers such plants as sugar cane, tea and legumes and grasses for livestock the story seems to be very different. My reasons for saying this are two. Firstly, crops grown for their vegetation are generally less influenced by day length adaptation than those grown for their seeds or fruits. Thus, Scottish seed potatoes are exported to all latitudes. Lucerne is grown over most of North America, but most good seed is produced in the south-western half of the U.S. Secondly, in Kenya–Uganda even when moisture was a serious limiting factor vegetative yields seemed to be on the high side. Indeed, given enough natural or irrigation water and adequately fertilized soils it would be difficult to imagine a theoretically better climate for vegetative growth and hence for livestock—if and when such troubles as rinderpest, tick fever and trypanosomiasis can be effectively controlled.

Thus improved varieties of some American legumes and grasses might justify extended trial in Kenya–Uganda. It is true that there are still many "ifs" and "buts" in the way of a significant livestock industry in Kenya–Uganda, but so there were 30 years ago in the south-east of the U.S.A.—an area where livestock is consistently expanding. Again, it may seem fanciful to talk of either surface or sprinkler irrigation as the basis of a livestock industry, but one has only to take one glance at some of the irrigated stock farms in the arid western States of the U.S.A. to realize its potentialities.

Land Tenure and Production Credit.

The share-cropping system of land tenure—referred to previously—is common throughout the southern States of the U.S. It has patent and well-known social disadvantages. But on the other hand it has some decided economic advantages, viz.—

(*a*) efficient supervision of low-income "farmers" and rapid introduction of new technical advances;

(*b*) easy access to capital and bank credit for irrigation, drainage, etc., for the purchase of fertilizers, etc., at wholesale rates and for mechanization;

(*c*) central specialized services (e.g. tractors, blacksmith, repair shops) which are beyond the technical and capital resources of the "share-cropper" farmers; and

(*d*) reasonable flexibility of cropping policy.

If the social stigma of this system should or could be avoided then the share-cropping system theoretically offers an approach both to the problem of bringing supervision, credit and mechanization to farms which are too small and to farmers who are not yet sufficiently developed to enjoy these advantages without outside assistance.

Another approach which has functioned reasonably well in the U.S.A. is that of the Farmers' Home Administration—a Federal agency which sets up good men with no capital on suitable farms, extends them credit and then supervises their operations fairly closely—but not as closely as an overseer on a share-cropping plantation.

The share-cropping system is based on an essentially personal relationship between the owner or overseer and the cropper. The F.H.A. system achieves much the same end with less danger of social abuse but with more red tape and less of that frequent personal contact between owner and tenant which seems so necessary in helping people of limited intelligence and very low incomes. A cross between the two might have more of the virtues and less of the vices of both. American experience in both these fields might have some useful applications in East Africa.

SUMMARY

To sum up. The similarity of Kenya–Uganda to the "Old South" of the U.S.A. is only superficial. Both regions grow, broadly speaking, a comparable range of crops—cotton, maize, sugar cane, sweet potatoes, etc.; both regions have warm temperate rather than Equatorial climates and have soil types to match; both regions have a large indigenous or derived African population with an upper social strata of European origin. But there the resemblances end.

In Kenya-Uganda temperature and day length are more or less constant, but rainfall tends to show two pronounced seasonal peaks each year. In the Old South the rain supply from month to month is relatively constant, but day length and temperature show marked winter and summer peaks. In Kenya–Uganda moisture; in the south-eastern U.S. temperature (either too high or too low) seems (apart from soil fertility) to be the limited factor to perpetual plant growth.

The negroes of the Old South have been directly subject to European influences for 150 years; the East African has only been indirectly influenced by the white man within the past 50 years. The American negro has been completely detribalized for more than a century; the East African is still tribal or semi-tribal. In the South no priority is accorded the coloured folk. In Kenya–Uganda the European is committed to a policy of helping the African to help himself and to utilize the fruits of European science. The fact that the American negro has a real income five to ten times greater than the East African shows what can be done and should give confidence to those who doubt these ultimate objectives.

These differences all limit the application of American "know-how" in East Africa. Broadly speaking, there seems to be little for Kenya–Uganda to learn from the U.S. at present about organization and marketing (including co-operatives and price control), about extension and advisory methods, or the administration of soil conservation and other official agricultural services. U.S. "know-how" on pest diseases; heavy farm machinery; livestock, including milk and egg production; fertilizer and pesticides—all these seem to me to be of limited value to Kenya–Uganda.

On the other hand, U.S. experience and ideas on soil management and water control, especially in relation to soil conservation, range management, stubble-mulching and other dry-farming techniques, water impounding and sprinkler irrigation all seem worth studying in Kenya–Uganda.

Abouts crops I am more doubtful. Although yields in the "Old South" are not really high they are greater than those found in Kenya–Uganda. But the climates, day lengths and general ecological conditions are so different that it is very unlikely that either improved U.S. crop varieties or production methods can be directly applied in Kenya–Uganda—which, it seems to me, must breed its own varieties and solve most of its own cultivation problems.

On the other hand, with vegetative crops, e.g. sweet potatoes, sugar cane and grass and legumes, there may be varieties or techniques which can usefully be imported from the U.S. In particular, overhead irrigation of market garden crops and even pastures seems worth looking into.

In the economic field the American share-cropping system and the supervised production credit system of the U.S. Farm and Home Administration may have features which could usefully be applied in parts of East Africa.

ACKNOWLEDGMENTS

Although I have been in America four and a half years and visited 47 out of the 48 States, I fully realize that my attempt, as a British agriculturist, to look at Kenya–Uganda in three weeks through American eyes must inevitably lead to some errors of judgment and fact. Without the assistance I have received from officials, research workers, farmers and traders in both North America and East Africa, these errors would be considerably greater in number and degree. I wish, therefore, to thank all those who have helped me in two continents.

CORRIGENDUM

The name of the author of the article on the "Construction of Pneumatic-tyred Vehicles on the Farm" in our April issue should read C. G. Glegg, Agricultural Officer, Tanganyika.

NOTES ON ANIMAL DISEASES

XXII—THE DIAGNOSIS OF ANIMAL DISEASES BY THE VETERINARY LABORATORY

By M. J. Fitzpatrick, Veterinary Research Laboratories, Kabete, Kenya

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While the diagnostic service of the Veterinary Laboratory at Kabete is intended primarily for the use of the Field Staff, it may be used in many cases by the public directly. The important proviso is that in so doing the stockowner does not delay the notification to the district veterinary staff of the possible existence of any of the scheduled diseases (listed later), as is required by law under the Diseases of Animals Ordinance. Where these notes describe methods for the diagnosis of the notifiable diseases, the information is to be used in collaboration with the district staff.

The number of trained veterinary staff in this country is very small, especially in relation to the distances between farms, with the result that stockowners seeking prompt diagnosis are often obliged to attempt procedures which in other countries would be left to the veterinarian. The following notes are intended to provide guidance in this difficult task, and careful study will bring more prompt diagnoses and greater personal safety to the stockowner coping with disease.

The subject is dealt with under the following heads:—

1. The provision of data on the disease problem.
2. Diagnostic methods used at the laboratory.
3. Animal diseases communicable to man.
4. How to deal with a carcass.
5. Selection of specimens for diagnosis.
6. Preparation and dispatch of specimens.
7. Biological and chemical examinations.
8. Evaluation of laboratory reports.

THE PROVISION OF DATA ON THE DISEASE PROBLEM

A full account of the symptoms and circumstances is much more likely to bring results than a sketchy post-mortem report or a jar of specimens selected at random, because while the stockowner may notice even slight abnormalities in the outward appearance of his animals, he lacks the technical knowledge necessary to describe disease in their internal organs.

Naturally the amount and type of information needed varies greatly in different cases, but besides the symptoms, which are discussed below, the following points are of importance:—

1. The proportion of the herd affected, the rate at which the disease seems to be spreading, and the factors common to the affected group, e.g. whether of the same sex, age or breeding group, bought from the same source, housed together, etc.
2. How often dipping is done, and what inoculations were given during the preceding year.

Reference should be made to any previous letters on the same problem, and the farm number given as well as the address. A copy of the letter should accompany any specimens sent, as a letter sent by post usually arrives later than a railed package.

When the disease seems to be spreading, it is important to inform the district veterinary office at once, as it is often possible to arrive at a diagnosis without consulting the laboratory, and even in doubtful cases, control measures can generally be instituted pending a definite diagnosis.

How to Describe the Symptoms

To write a good clinical description, one must be familiar with the appearance of healthy animals. Another essential is to be methodical in making and recording the examination, and a third to have a general idea of the changes common in sick animals. If the following list of symptoms is considered while the patient is examined, it may draw attention to points which might otherwise have been overlooked:—

A—Appearance

1. *Expression*: anxious, feverish, nervous, excitable, aggressive, dull, lethargic.
2. *General condition*: weak, thin, emaciated, dropsical.

3. *Skin*: weeping, dry, peeling, scurfy, crusted, lumpy, bald; bearing lice, ticks, stick-tight fleas; *coat*: matted, dry, rough, staring.
4. *Mucous membranes* (the linings of the eyelids and the natural openings): red, bluish, yellow, pale; with vesicles, pustules, ulcers, hæmorrhages, cheesy deposits, necrotic areas; smelling fœtid.
5. *Eyes*: cloudy, discharging, protruding, sunken, bloodshot; pupils contracted, dilated, unequal.
6. *Lymph-glands* (those most easily found being in front of the shoulder and stifle): enlarged (*see also* "swellings").

B—Temperature

High, low, fluctuating from day to day.

C—Behaviour

Coughing, shivering, dilating nostrils, facing the wind, groaning, grunting, grinding teeth, slavering, looking at flank, rolling, convulsions, staring, staggering, blindness, turning in circles, star-gazing, high-stepping, turning elbows out, vomiting, arching back, avoiding light, failing to cud, paralysis, coma.

D—Natural Functions

1. *Appetite and thirst*: reduced, increased, capricious, depraved.
2. *Respiration*: shallow, quick, slow, difficult, laboured, irregular.
3. *Heartbeat*: slow, fast, thumping, irregular, with pulse in jugular vein.
4. *Defæcation and urination*: frequent, suppressed, painful, forcible.
5. *Fæces*: hard, slimy, soft, fluid, frothy, clay-coloured, black, greenish; containing bloodclots, shreds of mucous membrane, worms.
6. *Urine*: pale, yellow, blood-tinged, viscid, cloudy, strong-smelling, forming a deposit on standing, containing bloodclots.
7. *Milk*: yellow, pink, with white clots, with bloodclots, ropy, smelling.

E—Swellings

Hot or cold, hard or soft, painful or painless, containing liquid or gas, pitting or crackling on pressure, tense or flabby, sharply or ill-defined, discharging, pointing (soft at one part), how distributed and of what size.

F—Discharges

Continuous or intermittent, clear, cloudy or purulent, watery or ropy, yellow, pink, blood-streaked, foul-smelling, from what source and how copious.

Diagnostic Methods used at the Laboratory

If something is known of the methods commonly used in veterinary diagnosis, it will be easier to understand the need for care in choosing and preparing specimens. The common procedures fall into four main groups:—

1. The naked-eye and microscopical examination of specimens.
2. The cultivation of parasites on artificial media.
3. The inoculation of experimental animals.
4. Serological tests.

When material has to be sent any distance, the problem is to prevent putrefaction. Preservatives such as formalin coagulate protein, thus destroying all life in the specimen, and fixing it in more or less its original state. Such material is suitable for the study of morbid changes and of such parasites as can be found by the microscope.

In many cases, however, the changes are not diagnostic of the disease, and the parasites ultravisible, rare or not identifiable by their appearance. The living parasite must then be recovered, for the study of its manner of growth on artificial media, or of its pathogenicity in experimental animals. Material for this purpose cannot be sterilized, yet must be protected from putrefaction, because putrefactive bacteria flourish better on artificial culture media than the specialized parasites of the living animal, and would overgrow them, and because the waste products of these bacteria are poisonous to experimental animals.

The problem of preserving specimens without destroying the parasites which they contain is approached in many ways, packing in sterile containers, refrigeration and speed in transport being those of most general utility, while drying is possible with some materials. The fact that certain chemicals attack bacteria while not affecting viruses is used in connexion with the diseases concerned. In the case of pleuro-pneumonia, for example, glycerine is used as a preservative, and in the case of swine fever, O.C.G. solution, which contains carbolic acid as well.

Serological diagnosis depends on the fact that when parasites invade the body, the serum acquires the power to attack them and their toxins in various ways, and that this action may be demonstrable in a test-tube. Since the serum acts only against the stimulating parasite and its closest relations, this provides a convenient means of diagnosis. The reaction, however, cannot be produced until a few weeks after infection has taken place, and this tends to restrict the usefulness of the test.

Past infections and protective inoculations also provoke these specific reactions for a period of time, but differ from active infections in that the strength of the reaction becomes steadily weaker, while that resulting from an active infection increases in strength for some time. It is to make this distinction that such tests are often repeated, usually after an interval of a month.

Blood for serological testing is allowed to clot, and the clear serum that exudes is used for the test. Sometimes the red corpuscles in the clot dissolve (hæmolyse), and the serum is so deeply coloured by their pigment as to make the test impossible. The only course then is to repeat the sample.

ANIMAL DISEASES COMMUNICABLE TO MAN

General Precautions

Whatever the disease, needless contact with any sick or dead animal is best avoided, the carcass, discharges, etc., should be destroyed, and any fixtures or appliances with which the animal has been in contact should be scrubbed clean with soapy disinfectant solution. When it is necessary to handle diseased animals, careful attention to the following precautions will greatly reduce the risk of infection:—

1. After touching contaminated material, do not smoke, eat or scratch insect bites, pimples or even the intact skin until the hands have been washed.
2. Wash the hands as soon as possible after touching the material, letting the water run over them for a little before any rubbing is started. A good soapy lather has a strongly antiseptic action.
3. If the clothes become soiled, change them before going on with any other work.

The first precaution is obvious in theory, but its practice demands a little thought, as the actions mentioned are often unconscious. As to the others, it should be borne in mind that disease germs may pass through skin that is apparently intact, especially if there is soaking or chafing, as when the hands are allowed to remain wet, or the edge of the sleeve or skirt has been soiled.

In dealing with disease in animals used as food, it should never be assumed that the uneducated African knows how to look after himself. Even after witnessing the violent death of an animal stricken with anthrax, Africans have been known on many occasions to dig up the carcass, eat it, and die of the disease themselves. While it is true that the majority of bovine diseases are not transmissible to man, many fatalities from food poisoning have followed the consumption of the flesh of animals dead from undiagnosed febrile conditions. Employers of primitive people should bear this in mind when tempted to make diseased carcasses available to their staff as food. If such carcasses cannot be burnt, they should be made unpalatable by treating with lime, paraffin or disinfectant before burial.

Diseases of Special Importance

Many of the parasites of the domesticated animals have been known to attack man. The following notes deal only with the more common or serious risks, and with those cases in which the disease resulting in man is difficult to diagnose unless the medical practitioner is aware of his patient's dealings with animals.

Abortion, Contagious Bovine or Caprine.—Cattle and goats which have never aborted, and which appear perfectly healthy, may nevertheless carry the causal organism of this disease in their systems, and distribute it in their milk, and in the fluids and membranes passed at parturition. The organism is easily killed by boiling and by antiseptics, but readily infects people who drink infected milk or remove retained placentas by hand. The resulting "undulant fever" may be mistaken for malaria. There are attacks of muscular pains, shivering and high temperature, followed by periods of normal health, and the disease may continue for a long time in this way. There are blood-tests by which the diagnosis may be confirmed.

Anthrax.—In an animal dead from anthrax, all the body-fluids are dangerous. If the carcass is left unopened, the organisms die when it decomposes, but if the fluids are exposed to air, the bacteria assume the form of spores after some hours, and these resist ten minutes boiling and all but the strongest disinfectants, and may remain alive in the soil, hide, wool, etc., for years. Disinfection should be done without delay when anthrax is suspected, in order to kill the bacteria before they have time to sporulate. Burial is not a safe method of disposing of the carcass, because if it is dug up and eaten by hyenas, these animals are likely to survive and spread the spores in their droppings, besides distributing the blood and other infective material.

Cows developing anthrax seldom secrete milk, but there have been cases in which the milk was infective, and any milk drawn within a few hours of the onset of symptoms or of death should be disinfected and effectively destroyed.

The symptoms of anthrax in man depend on the manner of infection. Thus, eating of the flesh usually produces gastro-enteritis, inhalation of spores from the dried hide or wool produces pneumonia, and infection of the skin results in an eruption known as "malignant pustule". Any form of anthrax in man is likely to end fatally if treatment is delayed.

Leptospiral Jaundice.—This disease has only recently been diagnosed in dogs in Kenya. Infection is most commonly contracted from the animal's urine, the causal organism possessing the ability to penetrate the intact skin. The resulting disease is one of the most serious that can be contracted from animals. There is usually no jaundice in man, but febrile symptoms are marked, and the disease progresses rapidly to a critical stage. When marked jaundice develops in a dog, veterinary advice should be sought without delay.

Psittacosis.—In man, influenza-like symptoms develop, which often progress to severe pneumonia. Infection may result from merely breathing the air in the vicinity of the affected bird. Parrots and related birds are most often affected, but pigeons and other birds have also been known to carry the infection. The "carrier" may appear to be in perfect health.

Rabies.—The saliva of the affected animal contains the virus, and penetration through skin injuries is the usual means of infection. Persons who have been in contact with a rabies-suspect dog should report to the medical authorities at once, as the protective inoculations must be begun as soon after infection as possible.

A rabid dog may not be vicious. It may remain perfectly quiet, becoming gradually paralysed, or it may fawn on its owner, or wander long distances from home, eating stones and foreign bodies. As a rule, the animal's face wears a peculiar anxious expression, and if it barks the voice is hoarse.

Rift Valley Fever.—Infection is contracted from sheep with extreme readiness. The resulting fever lasts up to a fortnight, and is accompanied by depression and sometimes eyestrain.

Ringworm and Mange.—These diseases are readily contracted from animals, and may persist obstinately. Ringworm is the more commonly transmitted, being contracted from cattle, dogs and cats, but grooms have been known to develop an ugly dermatitis from horse-mange.

In ringworm in the cat there may be only a few yellow crusts on the ears but if there are young children in the house the animal should be destroyed rather than treated, as children are very susceptible, and the disease may be very difficult to cure.

Tuberculosis.—The danger of infection through milk is well known, and the handling of a tuberculous carcass is unlikely to result in the infection of the operator if ordinary precautions are taken. It may be worth noting, however, that certain pet animals are subject to tuberculosis of the human type, and may easily transmit the disease to their owners, with serious results. Dogs, cats and monkeys with chronic lung trouble or undiagnosed wasting disease should be regarded as possibly tuberculous.

HOW TO DEAL WITH A CARCASS

A.—Begin by studying the notes on animal diseases communicable to man.

B.—To make a blood-film, cut into the base of an ear, as if to cut it off, then squeeze the ear, if necessary, to express blood from the severed veins. Ear blood is always used, as it stays fresh longer than the blood inside the body.

C.—To burn a large carcass without waste of fuel, dig two trenches in the form of a cross, each trench being seven feet long and fifteen inches wide, the depth increasing from a few inches at the ends to eighteen inches in the middle. Pile the earth into four heaps in the angles, and place two iron bars on them, so as to lie across one of the trenches. Lay strong wooden posts across the bars and set a fire of straw and wood on top, soaking it with waste oil. Place the carcass on top of the heap of fuel.

To burn a small carcass, soak the ground round about it with water, pour oil on the carcass, and set fire to it. Spray oil on the burning carcass with a stirrup pump, and throw wood on top.

D.—If there is a possibility of anthrax, proceed as follows:—

1. Make a blood-film.
2. In the case of a horse or pig, cut into the throat region and make a film from the fluid which exudes, also.
3. Burn the carcass as near the place of death as possible.
4. Search for any discharges which have come from the animal, and shovel them on to the fire, together with the soil where the animal was lying.
5. Disinfect the harness and appliances at once, as the organisms soon form spores which resist disinfectants, and may infect other animals.

E.—If there is a possibility of rabies, soak the carcass in disinfectant, making sure that the mouth is filled, and bring it at once to a veterinary officer. If the brain is allowed to decompose, diagnosis may not be possible.

F.—To open a carcass, begin by skinning it completely if the hide is wanted, then proceed as follows:—

1. Lay the carcass on its right side.
2. Cut through the muscles which hold the forelimb in place, and lay it back clear of the ribs.
3. Cut into the groin, sever the ligaments of the hip joint, and lay the hind leg back.
4. Skin the chest and belly, if this has not already been done.
5. Push the knife between the ribs, near the neck, and slide it along to the breastbone, then turning the knife, cut through the cartilages which unite the ribs to the breastbone, and continue the cut through the belly wall.
6. Separate the ribs from the belly wall and from each other, and pull them back till their joints break.
7. The abdominal organs are held in place mainly by thin membranes which tear easily. Use the knife carefully in removing them, so as to avoid cutting the stomach and large veins.

   Remove the organs in the following order, washing them in water: spleen (attached to the stomach), left kidney (attached to the backbone), stomach and intestines, liver, right kidney, heart, lungs.

   The mesenteric lymph-glands are in the thin membrane which connects the bowel with the backbone. The largest carcass lymph-glands are a hands-breadth in front of the shoulder, and just above and in front of the stifle joints respectively.
8. To expose the brain of a ruminant, first detach the head by cutting through the joint at the base of the skull, then skin the top of the head, and break through the bone just inside the horn-roots with a panga or chisel. Continue the cut from just behind the eye-sockets to the opening for the spinal cord, make a transverse cut behind the eyes, and prise off the piece of bone thus separated.

THE SELECTION OF SPECIMENS FOR DIAGNOSIS

Before taking specimens, be sure that you are familiar, firstly with the symptoms of the diseases from which man may be infected, and secondly with the requirements of the Diseases of Animals Ordinance regarding notification of disease and isolation of affected animals. Then proceed as follows:—

A.—For the diagnosis of disease in poultry, send sick birds or unopened carcasses. Bacillary white diarrhœa, tuberculosis and fowl paralysis are notifiable.

B.—If an animal has died and there is no suspicion of dangerous or notifiable disease:—

1. Make a blood-film at once.
2. If you live within a few miles of the laboratory, send also the unopened carcass.
3. If you live at a distance from the laboratory, send also smears from the spleen and lymph-gland.

C.—If you suspect some particular disease, consult the list and prepare and dispatch the specimens carefully as directed in the section on that subject. In the case of the notifiable diseases, the laboratory may be approached directly only by prior arrangement with the district veterinary staff.

Most of the diseases named in the following list are described in the pamphlets issued by the Department. Diseases notifiable at the time of publication are marked (N).

Please note, firstly, that the field veterinarian can very often reach a diagnosis without sending specimens, and secondly, that the specimens named, although often of assistance towards diagnosis, are by no means uniformly successful:—

Any Animal

Disease Suspected	*Material Required*
Trypanosomiasis (N)	Blood- and gland-films, thick drop.
Tuberculosis (N)	Smears from the affected tissue, tissue in formalin; fresh milk if udder infection is suspected.
Anthrax (N) Rabies (N)	*See* notes on human infection and on the handling of carcasses.
Mange (N in horse and mule).	Skin scrapings.
Ringworm	Skin scrapings.
Streptothricosis	Skin scrapings.
Anæmia	Thin blood films.
Hæmorrhagic Septicæmia Snakebite	Films of blood and gland and of fluid in swellings (if any); blood in citrate.
Abscesses	Pus from unopened lesion, swab.
Mastitis	Fresh milk.
Navel Ill	Fresh navel tissue or carcass.
Pneumonia	Fresh lung and lung in formalin.
Worms in Bowel	Fæces.
Worms in Tissue	Affected part in formalin.
Poisoning	*See* notes on biological and chemical investigations.

Horses

Epizootic Lymphangitis (N).	Pus from unopened lesion, pus films.
Ulcerative Lymphangitis (N).	Pus from unopened lesion, pus films.
Glanders (N)	Contact district veterinary staff.
Abortion	Blood for serum, drawn at least 14 days after the abortion; unopened fœtus.
Biliary Fever	Blood-films.
Horse-sickness	Blood in O.C.G.

Sheep

Heartwater (N)	Brain films and brain in glycerine.
Pox (N)	Contact district veterinary staff.
Scab (N)	Skin scrapings.
Enterotoxæmia Lamb Dysentery	Bowel contents in chloroform (not formalin), smears of contents of small bowel.
Pulpy Kidney	Kidney in 50 per cent glycerine.
Bluetongue	Blood in O.C.G.
Nairobi Sheep Disease	Blood in O.C.G.
Rift Valley Fever	Blood in citrate.
Lymphadenitis	Fresh pus and pus films.
Laikipia Lung Disease	Fresh lung and lung in formalin, sick sheep.

Pigs

Disease Suspected	*Material Required*
Erysipelas (N)	Sick pig or fresh carcass.
Swine Fever (N)	Blood in O.C.G.
Piroplasmosis	Blood-films.
Influenza	Fresh lung and lung in formalin.

Cattle

Heartwater (N)	Brain smears, brain in glycerine.
Contagious Pleuro-pneumonia (N).	Blood for serum, or lung specimens in formalin and in glycerine.
Rinderpest (N)	Blood in citrate.
Foot-and-mouth Disease (N).	Contact district veterinary staff.
Farcy (N)	Fresh pus and pus films.
Actinomycosis	Fresh pus and pus films, affected tissue in formalin.
East Coast Fever (N)	Films of blood, spleen and gland.
Turning Sickness	Films of blood, spleen and gland, and brain-films.
Anaplasmosis	Blood-films.
Redwater	Blood-films.
Enzootic Hæmaturia	Blood films and bladder in formalin.
Calf Diphtheria	Affected part in formalin.
Johne's Disease	Junction of large and small bowel in formalin, smears from adjacent mesenteric glands; rectal snippings.
Coccidiosis	Junction of large and small bowel in formalin; fæces.
Malignant Catarrh	Liver, kidney and brain in formalin; fresh lymph-gland, blood in citrate.
Contagious Abortion	Blood for serum, drawn at least 14 days after the abortion.
Paratyphoid Scours	Sick calf, fresh liver and mesenteric gland.
Blackquarter	Dried muscle from the swelling, smears from the affected muscle. (The carcass should be cut as little as possible, and disposed of in the same way as an anthrax-suspect carcass, otherwise the infection may remain alive in the soil for years.)
Contagious Ophthalmia.	Swab from the eye.

Dogs

Tick Fever	*Blood-films.
Filariasis	*Blood-films.
Rickettsia	*Blood-films.
Coccidiosis	Fæces.
Leptospiral Jaundice	Sick or dead dog.

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* It will usually be found much more satisfactory to bring the dog to a veterinarian for clinical examination.

THE PREPARATION AND DISPATCH OF SPECIMENS

GENERAL NOTES

A—General Advice

1. When an organ is diseased in part, send a piece which includes the margin between the diseased and healthy tissue.

2. Send three to four ounces of the material, unless otherwise indicated.

3. Pack the material in a watertight container, surrounding this with enough absorbent material to soak up any fluid which might exude in the event of breakage.

4. Send the material by rail if possible, and include a covering letter with the package.

5. If the material is posted, it must be sent letter post, and clearly marked "Fragile with Care, Pathological Specimen". It must be in a sealed container, packed in a wood, leather or metal box so that it cannot move about, and surrounded with enough absorbent material to make leakage impossible (cf. Post Office Guide).

B—Equipment

The following equipment is obtainable from the laboratory for the preparation of specimens:—

1. Glass slides, 3 in. by 1 in.
2. Folders for wrapping slides, recording name and address, etc.
3. Sterile swabs, bottles and corked tubes.
4. Jars containing 10 per cent formalin or 50 per cent glycerine.
5. Bottles containing citrate or O.C.G.

Formalin kills bacteria, viruses, worms and insects, and preserves the tissues. Glycerine kills most bacteria, and preserves viruses. Citrate and oxalate prevent clotting of blood, but do not preserve it. "O.C.G." consists of oxalate, carbolic acid and 50 per cent glycerine. It prevents clotting of blood, kills bacteria and preserves certain viruses.

Jars containing chloroform (for enterotoxæmia diagnosis) may be obtained from the district veterinary officer.

THE PREPARATION AND DISPATCH OF SLIDES

A—General Advice

1. If advice cannot be obtained at once, take the temperature every morning, and make the films when fever is detected.

2. Send the slides in pairs, tied together, back to back. If a single slide is sent in a wrapper or envelope, it will break in the post.

3. If the slides are stuck together while wet, the material will decompose, and examination may disclose only putrefactive bacteria.

B—Preparation of Blood-films

1. Polish two slides with a clean handkerchief.

2. Clip the hair from the edge of the animal's ear, and prick the skin with a needle. In the horse, prick one of the ear veins.

3. Touch the blood with one of the slides, near one end of the slide and place the slide on a flat surface.

4. Hold the second slide over the spot of blood, and lower one end till the short edge touches the centre of the other slide. (Fig. 1.)

5. Draw the edge of the upper slide along the lower till it touches the blood, which will then spread along the angle made by the two slides. (Fig. 2.)

6. Push the edge steadily back along the lower slide, so that it draws the blood after it. (Fig. 3.)

7. Wave the blood-film in the air until it is quite dry.

For thin films, use less blood, and keep the slides at a very narrow angle when spreading it. The spreading slide should be kept a little to one side, so that the blood-film does not cover the whole width of the other slide. The area covered should be about 2 in. by $\frac{1}{2}$ in., fading out at one end. (Fig. 4.)

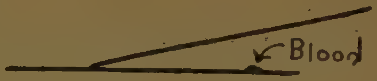


Fig. 1

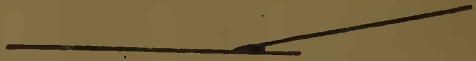


Fig. 2

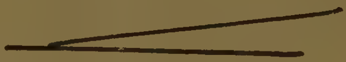


Fig. 3

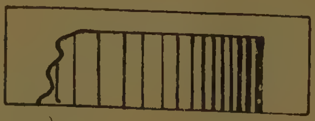


Fig. 4

THE PREPARATION OF A BLOOD-FILM

C—Thick Drops

Spread four drops of blood over a square half an inch across on a slide, and leave it till quite dry in a place free from dust and insects.

D—Films of Gland-fluid, etc.

Films of any watery fluid are made like blood-films, while pus, spleen-pulp and the like are smeared thinly and evenly over the slide.

To prepare a gland-film from a live animal, first find the prescapular gland, which is a handsbreadth in front of the shoulder joint, then clip and disinfect the area. Grasping the gland in one hand, with the skin stretched tightly over it, push a strong hypodermic needle into its substance, and move the point slightly from side to side. Withdraw the needle, and expel the fluid on to a clean slide.

E—Smears from Tissue

Cut through the diseased tissue, and while the surface is still moist, rub it firmly against the slide.

F—Brain Smears

The greater part of the brain consists of two roughly oval lobes, with an irregularly grooved surface. Cut one of these across, half way along, and with a knife-point, dig a little "pea" from the greyish outer layer. Squeeze this between the centres of two slides, rub the slides firmly together, and slide them apart sideways. Let the smears dry, and send them both.

The Preparation and Dispatch of Fresh Specimens

These are sent without preservative, in the sterile containers provided or in a freshly boiled and cooled jar or bottle. Avoid handling the material, refrigerate it till it can be sent, and send it as soon as possible.

If the specimen is to be more than a few hours in transit, cut into the diseased tissue with a sterile knife, and rub a swab against the moist surface. Send the swab (in its tube) together with the specimen.

A—How to Collect Blood

Take the animal into a dust-free place. Clip and disinfect a small area over the jugular vein (i.e. in the groove just above the windpipe), in the lower half of the neck, encircle the neck below this level with a cord having a slipknot, and tighten the cord. The vein will swell up with blood. Insert into the vein, almost parallel with it, a wide-bored needle with a very sharp point. If blood does not flow, withdraw the needle slightly, and move the point from side to side. Some people find it easier to stab the vein sharply, with the needle at right angles to it.

An assistant should hold the bottle, open it long enough to catch the blood, and close it quickly. Then slacken the cord and withdraw the needle.

B—Blood for serum

The needle and tube used must be dry as well as sterile, or hæmolysis is likely to occur. Fill a tube one-third full of blood, and cork it securely. Then lay it almost flat till clotting is complete before sending it.

C—Blood in O.C.G. and Citrate

The O.C.G. and citrate bottles contain enough anticoagulant for the amount of blood they can hold. If a number of animals are ill, take blood from one with a high temperature.

D—Long Bone

Where blood in O.C.G. or citrate would be taken from a live animal, the proper specimen to take from a carcass is a long bone. Cut through the knee joint, and send the lower leg, wrapped in a cloth soaked in 2 per cent lysol or equivalent antiseptic.

E—Milk for Mastitis Diagnosis

Wash and dry the hands and udder, and strip the healthy quarters. Catch the first few spurts from the diseased quarter in disinfectant and discard them. Then fill a tube with the milk and close it at once.

F—Pus and Fluid from Swellings

Clip and clean the lower part of the swelling, draw a few c.c.'s of the contents into a sterile syringe, and expel this into a tube. If there are a number of abscesses, use one that is about to burst. Sterilize the syringe and needle after use.

G—Swabs

If there are no unopened abscesses, rub a swab firmly against an opened one. Do not allow the swab to touch anything other than the diseased surface, and if the lesions are being treated with antiseptic, leave this till after the swab has been taken.

The Preparation and Dispatch of Preserved Specimens

Do not allow the material to decompose before preserving it.

A—Dried Muscle

Cut deeply into the swelling and remove a piece of muscle. Slice off a strip about 3 in. by 1 in. and $\frac{1}{8}$ in. thick, dry it with blotting paper, and place it in the sun under fly-proof netting until it is so dry as to be brittle.

B—Skin Scrapings

Try to get enough material to fill a thimble, and send it in a small bottle. Skin scrapings from small animals are better examined on the spot. It takes skill to find the right material, and as a rule the quantity taken is so small that there is almost nothing to be found in the "samples" that arrive at the laboratory.

C—Rectal Snippings

Little pieces are pinched off the lining of the bowel, and placed in a tube with a little alcohol. This should be done by a trained person.

BIOLOGICAL AND CHEMICAL EXAMINATIONS

A—Suspected Poisoning

1. *Botanical Investigations.*—Poisonous plants occur on most farms, and the main point in proving plant poisoning is to be certain that the animals have actually eaten the plants, which they seldom do. Look for the plant in the animal's stomach, and note whether there is a shortage of normal grazing, and how common the poisonous plant is on the pasture.

For identification of a plant, find a complete flowering specimen, and if possible one with fruit. Send them pressed between sheets of newspaper. For feeding tests, send several pounds weight of the plant.

2. *Chemical Analysis.*—As there are very many chemical poisons, each detected by a different test, it is useless to say "suspected poisoning" without making a suggestion as to which poison is likely to be involved, or at least which class of poison, e.g. corrosive poison, alkaloid, glucoside, etc. If no poison is named, a test will be done for arsenic, as this is by far the most common cause of the poisoning of animals in this country.

Information sent with the specimen should include the reason for suspecting poisoning, the symptoms (especially the presence or absence of dilatation or contraction of the pupils, coma, nervous symptoms, vomiting and diarrhœa), and the pathological changes (with especial reference to the stomach and intestines, liver, kidneys, heart and lungs).

Tests for arsenic and other mineral poisons are undertaken at the Veterinary Laboratory. Send about four to six ounces each of the fourth stomach and of its contents preserved in spirit.

Tests for alkaloids and other plant poisons, and tests to determine the amount of poison present (as may be necessary if legal action is contemplated) involve a complicated and time-consuming procedure. This work may be undertaken by the Government Chemist, provided that a veterinary surgeon investigating the case is of opinion that the circumstances warrant it.

Specimens for this purpose should include about eight ounces of the wall of the fourth stomach, a similar amount of its contents, a kidney and about a pound of the liver, and should be preserved in spirit (not formalin).

B—Entomological Examinations

Ticks.—Either wrap them separately in soft paper and pack them in a box, or place them in a bottle with ten per cent formalin.

Flies.—Pin the fly through its broadest part to the narrow end of a cork of suitable size, and plug this into a bottle.

Supply the following particulars:—

1. Date and exact locality of catching the insect.
2. The host on which it was feeding, and the circumstances under which it was caught.
3. The farm number as well as the postal address.

C—Dip Testing

Fill a pint bottle as the last of a batch of animals goes through the dip. State on the label the make and type of dip and the interval between dippings, as well as the name and address.

D—Estimation of Butterfat and Total Solids in Milk

Apply to the laboratory for bottles containing the preservatives appropriate to these tests. As the constituents of milk separate out rapidly on standing, mix the bulk of milk very thoroughly before sampling.

E—Analysis of Urine

The routine tests for albumen, etc., are done, but as the interpretation of the results requires specialized knowledge, there is no point in sending such specimens unless in consultation with a veterinary surgeon.

F—Diagnosis of Pregnancy in Mares

This test is positive only if the mare has been pregnant two months or more. Catch some urine in the morning, fill a clean six-ounce bottle with it before it cools, and cork the bottle at once. Add no preservative. Supply the following particulars:—

1. Name and age of mare.
2. Date of service and of taking the sample.
3. State of the mare's health, and previous breeding history.
4. (If possible) whether service was on the first, second, third or other day of the heat period.
5. Whether a specimen has already been sent from this animal. Enclose a cheque for Sh. 7/50, and send to "Experimental Station, Box 25, Naivasha".

THE EVALUATION OF REPORTS

Scientific methods have not yet reached the stage where a test or analysis of material will automatically yield a diagnosis of the disease involved. In fact, examination of material usually provides merely items of information, which are added to the data accompanying the specimens, the result varying from a clear-cut diagnosis in some cases, to a mere suggestion or list of possibilities in others. In other words, if the information accompanying a specimen is inadequate or inaccurate, the report is likely to be of diminished value, and may even be misleading. There are certain cases in which this is particularly likely to occur, the following being the principal of these.

1—When Different Causes Succeed Each Other in Disease

The simplest example is probably the breakdown to redwater or anaplasmosis seen in animals premunized against these diseases. Such animals carry the protozoan parasite in their systems, but not in such numbers as to cause clinical symptoms of disease. If such an animal contracts, say, pneumonia, the lowering of its bodily strength permits the protozoan parasite to multiply in its blood. If, then, a blood-film is sent without complete clinical information, the report will merely say "redwater" or "anaplasmosis", and the primary cause may go undiscovered.

2—When Different Causes Exist Together

Dysentery in calves, to name only one example, might be due exclusively to coccidiosis or to rinderpest, but in some outbreaks both causes operate together. In such a case, if the stockowner did not suspect rinderpest, and sent in a specimen of fæces without adequate information, the report would confirm his diagnosis of coccidiosis, and the more serious disease would remain undiscovered.

3—When a Given Parasite has Pathogenic and Harmless Strains

A further cause of confusion lies in the fact that a given species of organism may have virulent and harmless strains, which are of identical appearance, and which can be differentiated by culture and inoculation only with difficulty. Furthermore, the resistance of individual animals to certain of these organisms varies a great deal. The causal organisms of hæmorrhagic septicæmia, enterotoxæmia and colon-bacillosis, to name only a few, are in this group, and whether one of them, on being found, is incriminated as a disease-producer or disregarded may depend entirely on the accompanying information.

A number of the more common diseases may be diagnosed by detecting the causal parasites in a blood-film examined under the microscope. As only a very small volume of blood can be examined in this way, however, parasites are unlikely to be found unless present in considerable number, so that the report "no parasites seen" may be returned in the early stages of a protozoan blood-infection or during the quiescent periods of a recurrent disease such as trypanosomiasis, as well as in cases where these diseases are absent.

If the negative report is on a slide taken during a period of high fever, then it may be concluded that the existence of a protozoan blood-infection is very unlikely.

While, on occasions when veterinary advice is not obtainable locally, it may be necessary to send specimens directly to Kabete, the stockowner will save himself much perplexity, to say the least of it, if he makes a point of consulting the field veterinarians as soon as possible. He is, of course, bound to do so in cases where there is any likelihood that a notifiable disease is involved.

It should be borne in mind in consulting the district Government staff, that their duty is to administer the Diseases of Animals Ordinance.

RAIN-WATER PENETRATION IN BRITISH SOMALILAND SOILS

By P. E. Glover, E.A. Tsetse and Trypanosomiasis Research Organization

(*Received for publication on 20th January, 1950*)

Whilst examining the roots of *Acacia socotrana* Balf.f. at Ged Dobo in the Guban (Coastal Plain of British Somaliland) it was observed that even as long as four days after rain had fallen a clearly visible and well-defined moisture penetration line could be seen on the freshly dug soil profiles, by the fact that the soil above it appeared wetter and darker than that beneath it. This suggested that there might be a relationship between the top cover, the root growth form of plants, and the visible penetration depths of rain-water into the soil. The experiments described below show that the original idea was in general correct, but a striking correlation between denuded ground and depth of moisture penetration is also shown. Since these experiments were undertaken in the process of a survey of the "Devastated Areas of British Somaliland", the importance of the results in showing the effect of denudation on run-off, and penetration of rain-water, could not be overlooked.

Objects of the Experiments

(1) To determine the rate and depth of visible moisture penetration after rain had fallen in different types of trampled and eroded soil.

(2) To find out whether there was any connexion between surface vegetation, the variations in soil level and the rate and depth of visible moisture penetration after rain.

(3) To discover if there was any correlation between root habit and rain-water penetration in different types of trampled and eroded soils.

Experiment 1.—Ged Dobo

The first experiments were conducted at Ged Dobo in the Guban, latitude 10° 7′ 30″ N. (approx.) and longitude 45° 12′ 30″ E. (approx.), altitude 1,900 feet, and an approximate annual average rainfall of between eight and ten inches. The vegetation was of the Haud Type (Gillett, 1941).

The soil was a grey alluvial sand which varied in coarseness and had a gravel bed three inches thick which occurred at depths varying from fifteen inches to three feet below the surface. Signs of severe trampling and in consequence sheet as well as gully erosion were evident.

Method.—Half an inch of rain fell on 18th May, 1945, from 4 p.m. to 4.30 p.m.

On the morning of the 19th at 6 a.m. two trenches were dug fifty-five feet long, three feet deep, and one foot wide on level ground, through a stand of *Iphiona rotundifolia* Oliv. and Hiern and *Eragrostis hararensis* Chiov. The visible rain-water penetration line could be seen clearly in both walls. The fluctuations in depth of the visible moisture line, in each trench, were measured with a ruler all the way along one wall at intervals of one foot (fig. 1, A and B). Wherever possible the experiments were conducted in the early morning to prevent the sun from drying the exposed surface, which was continually scraped to keep the moisture line fresh and clear.

Observations.—Examination of graphs A and B (fig. 1), reveals high points at intervals along the line showing the soil surface (soil level). These high points represent small mounds of sand around the bases of the plants growing on the edges of the trenches. In most cases there was a film of *Alga* covering the mounds. The lower lines represent the visible water penetration depths along the walls of trenches A and B. It will be seen that the deepest penetration is not immediately below the plants growing above, but to one side. The cause of this was due to the sandy nature of the soil (which absorbed the water readily) and the *Alga* covered sand mounds around the the plants which caused the rain-water to run away from, and not to penetrate deeply through the soil immediately beneath them.

On the 23rd May, 1945, one inch of rain fell in a short sharp shower between 4.30 p.m. and 5 p.m. Digging was begun on two trenches an hour after the rain had fallen. Two sites covered with a surface film of *Alga*, but no other vegetation were chosen. Pit No. 1 (fig. 2) was also on the algal covered sloping ground, but was dug at right angles to the general slope. The next morning 14 hours after the rain, a new surface was exposed on Pits 1 and 2 by digging the wall back a foot and smoothing it off again (fig. 2).

The graphs of Pit No. 1 and Pit No. 2 (fig. 2) show;—

(1) That moisture penetration is deeper at right angles to the general slope than it is parallel with the general slope.

(2) That the moisture had made the greater part of its penetration by the time measurements were taken two hours after the rain. Only slightly deeper penetration took place during the next twelve hours, and two points on graph 2 (Pit 2) would seem to indicate that the visible moisture line had already begun to recede, apart from the fact that it had levelled out considerably.

(3) A comparison of fig. 2 with fig. 1, shows that where there is an encrustation of *Alga* covering the soil surface, it tends to prevent the penetration of rain-water into the soil, especially in the case of short sharp showers which are not of long enough duration to penetrate the *Alga* film.

(4) The visible rain-water penetration into open *Alga* covered soil with no other vegetation present was much more even than that which was not uniformly *Alga* covered, but where other plants were present (cf. figs. 1 and 2).

Pits 3 and 4 were completed and examined 14 hours after rain on the 22nd, but on different sites from Pits 1 and 2. Pit 3 was dug on open flat ground covered with *Alga,* and Pit 4 was dug on open *Alga* covered ground with a slight slope and parallel to the slope. It will be seen that in these also (fig. 2, graph 3), the visible moisture penetration levels are flatter and are not as deep as those in fig. 1, A and B.

In addition to the pits already discussed a trench 55 feet long on a different site was completed and examined on the morning of the 23rd of May 14 hours after one inch of rain had fallen. The object here was to find out what effect a line of gravel at varying depths below the soil surface would have on the penetration of rain-water into the soil. Examination of fig. 3 shows that though the plants on the surface have a somewhat similar influence on the moisture level to those in fig. 1 (cf. fig. 5, graph 2) the visible moisture level adhered very closely to the same line as the gravel level and did not penetrate very much past it. In other words, the coarse nature of the gravel layer broke the smooth flow of moisture through the more homogeneous soil and acted as a buffer to deeper penetration.

Experiment 2—Jerin

The experiments were carried out at Jerin, latitude 9° 30′ N. (approx.), longitude 45° 21′ 30″ E. (approx.), altitude 3,860 feet (approx.). The annual rainfall was between six and eight inches, and the type of vegetation was *Acacia bussei* open woodland (Gillett, 1941).

The soil was a heavy brown clay loam overlying "pans" of limey concretions (travertine or calcareous tufa). It showed varying degrees of trampling, but the landscape was generally flat and the deeper soil carried thick clumps of *Andropogon cyrtocladus* Stapf, "Dur".

An inch and a half of rain fell in a very heavy shower during the night of August the 10th, 1945. On the morning of August the 11th at 8. a.m. three trenches were dug:—

(1) Trench 1 was on a light slope and parallel with it through a stand of *Sporobolus* sp., *Justicia minutifolia* Chiov., *Indigofera ruspoli* Bak.f., etc., and passing into a stand of *Andropogon cyrtocladus* Stapf. There was a film of sandy soil about half an inch thick overlying the heavier soil. An examination of graph 1 (fig. 4) shows that in every case there is a marked depression in the moisture penetration line opposite the plant growing above it. (The arrows marked "Line of Wash" denote the direction of slope and run-off.)

(2) Trench 2 was dug on level ground 20 feet to the south of trench 1, commencing in an open stand of *Justicia minutifolia* Chiov., *Vernonia cinerascens* Sch. Bip. with small tufts of *Andropogon cyrtocladus* Stapf, "Dur" and passing into a sward with large tufts of *Andropogon cyrtocladus* Stapf (graph 2, fig. 4). It will be seen here that the correlation between the plants on the surface and the visible moisture penetration line is almost classic. There can be no mistake about the very strong depression in the moisture line beneath each plant. When the large tussocks of *Andropogon cyrtocladus* Stapf are reached the moisture line drops right down to the travertine level and stays there. (It was not possible to discover how thick the travertine layer was, or how deeply the moisture had penetrated into it.)

(3) Trench 3 was 15 feet long, dug from the centre of a large tussock of *Andropogon cyrtocladus* Stapf and about six feet to the north of trench 2. The same

marked phenomena seen in trench 1 and 2, are shown here. (The brackets marked "Dur" above the soil surface lines in all three graphs, fig. 4, show the diameter of the tussocks of *Andropogon cyrtocladus* Stapf.)

Experiment 3—Alablah

The third and last batch of experiments were carried out at Alablah in Somalia, latitude 8° 2′ N. (approx.), longitude 44° 22′ E. (approx.), altitude 2,500 feet, and an approximate average rainfall of between six and eight inches.

The soil in this locality was light reddish yellow and sandy to a depth of one foot, from there it became more clayey, harder and chocolate red in colour to depths varying between two and two and a half feet where decomposing limestone appeared, but this change did not seem to influence the visible moisture penetration line, as was the case with the gravel layer in Experiment 1 (fig. 3).

A light shower of 0.15 inches of rain fell at 4 p.m. on the afternoon of the 1st October, 1945, and 0.25 inches fell during the night of 6th October. At 8.30 a.m. on the 7th October, the first trench was dug in the same manner as in Experiments 1 and 2 (graph 1, fig. 5) in flat open ground in a sward of *Chrysopogon aucheri* Stapf, *Sida* sp., and *Aristida* sp.

Trench 1 (graph 1, fig. 5) shows similar depressions in the moisture line, below the plants on the surface, to those shown in Experiment 2 (fig. 4).

During the night of the 7th October, 0.50 inches of rain fell in a steady shower which lasted for one hour. At 8.30 a.m. on the morning of the 8th, trench No. 2 was dug on open flat ground through a stand of *Aristida* sp., *Chrysopogon aucheri* Stapf, *Andropogon cyrtocladus* Stapf and patches of *Alga* encrustation. The soil was identical with that in the the first trench. Graph 2, fig. 5, shows the same depressions in the visible moisture line opposite the plants on the surface and confirms the evidence in graphs 1, 2 and 3, fig. 2, where it is shown that the *Alga* encrustation tends to prevent the penetration into the soil of rain-water.

Discussion

It would seem from the evidence in figs. 4 and 5, that the "top hamper" of herbaceous plants (especially grasses such as *Andropogon cyrtocladus* Stapf), acts as a retainer which retards and even holds the flow of water, thus allowing it to penetrate and be absorbed by the capillaries in the soil made by dead and decaying roots which would help it to permeate to greater depths. A considerable amount of rain-water could be caught in this way, but in regions where the herbaceous cover had been denuded there could be very little penetration and a very great run-off. Because of this, when the vegetation becomes more and more devastated as a result of overstocking, the availability of rain-water becomes so reduced that artificial drought conditions are produced, which lead to the erroneous idea that the average annual rainfall has decreased.

Conclusions

(1) Herbaceous vegetation and cover is a vital factor in preventing run-off and promoting the soil penetration of rain-water.

(2) The presence of a coarse gravel layer a few inches below the surface of the soil acts as a "buffer" to the penetration of moisture into the soil after rain.

(3) An *Alga* encrustation on open soil tends to prevent penetration of rain-water into the the soil.

(4) A number of Somaliland plants have developed extensive shallow lateral root systems as an adaptation to shallow penetration of rain-water after short sporadic showers.

(5) The shallow lateral root systems of many Somaliland plants render them most vulnerable to exposure by trampling and erosion with consequent overheating and drying out of the soil.

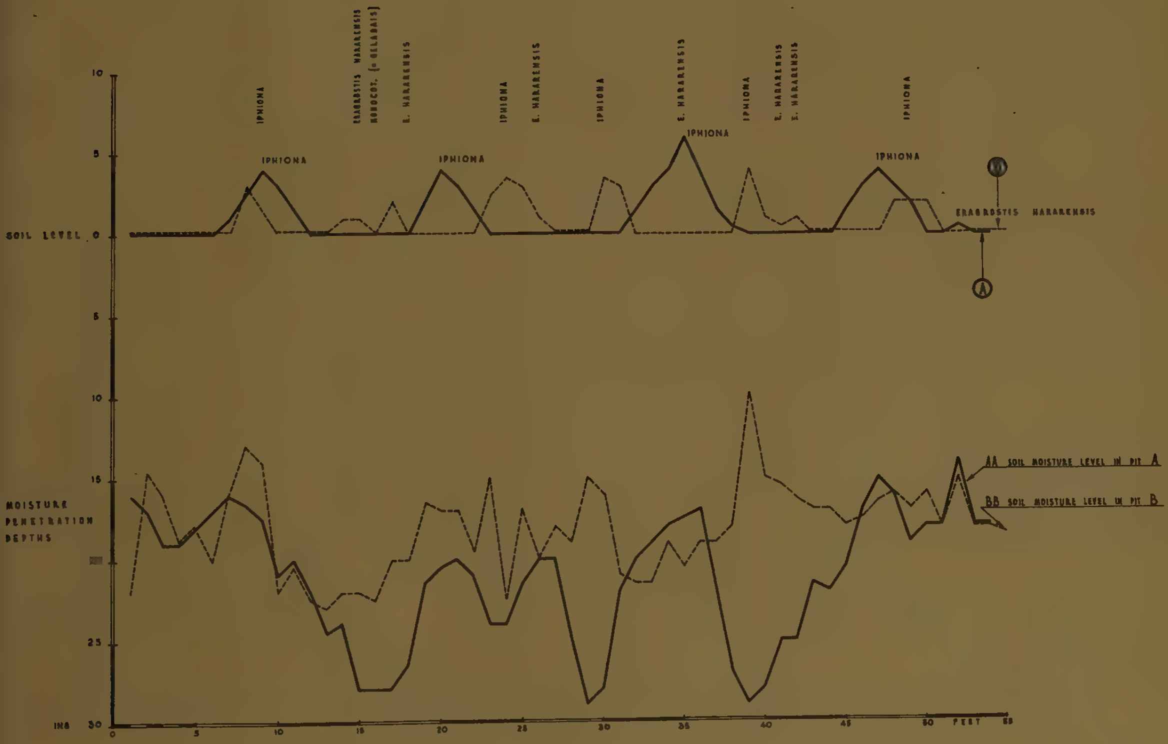
The simple experiments described in this paper are based entirely on the visibility of soil moisture penetration after rain, and it is regretted that they could not be supported by data from water retaining capacity experiments, and physical and chemical soil analyses. Neither the equipment, the time nor the staff were available for this.

However, it is hoped that such facilities may be available to officers working in the territory in the future and that they may be able to provide further data to amplify or modify these findings.

Note.—The *Alga* was examined under the microscope and found to be blue-green in colour and very finely filamentous with narrow discoid cells reminiscent of *Oscillatoria*. But beyond that, it is still unidentified. It was found to be very widely spread throughout the country.

DIAGRAMS TO SHOW CORRELATION BETWEEN PRESENCE
OF IPHIONA ROTUNDIFOLIA, ETC. AND MOISTURE PENETRATION LINE IN SOIL
14 HOURS AFTER HALF AN INCH OF RAIN
AT GED DOBO, LOWER SHEIKH
18TH MAY 1945

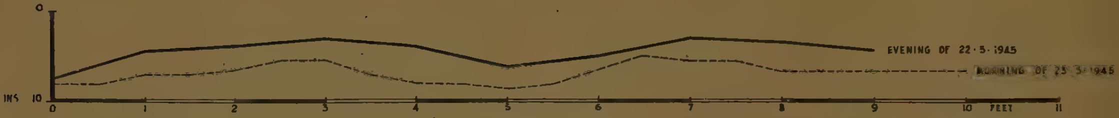
Figure I



GRAPHS TO SHOW SOIL MOISTURE PENETRATIONS IN ALLUVIAL SAND SHOWING PENETRATION ON FLAT AND SLOPING GROUND AT GED DOBO, LOWER SHEIKH AFTER ONE INCH OF RAIN ON 23RD MAY 1945

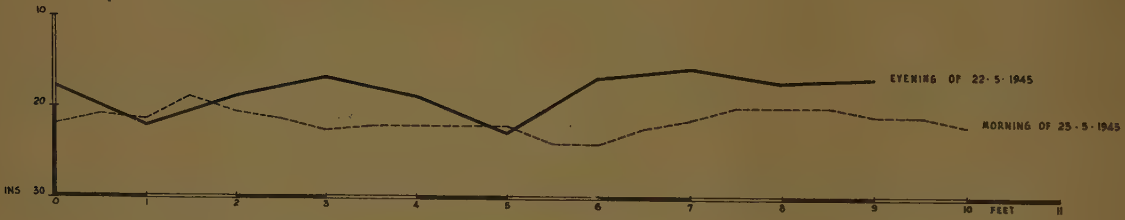
EVENING READINGS 2 HOURS AFTER RAIN
MORNING READINGS 14 HOURS AFTER RAIN

Figure 2



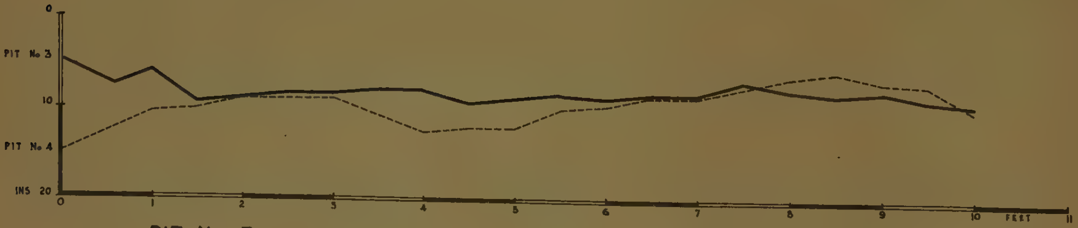
PIT No. 1

OPEN ALGAL-COVERED SLOPING GROUND RUNNING WITH GENERAL GROUND SLOPE.



PIT No. 2

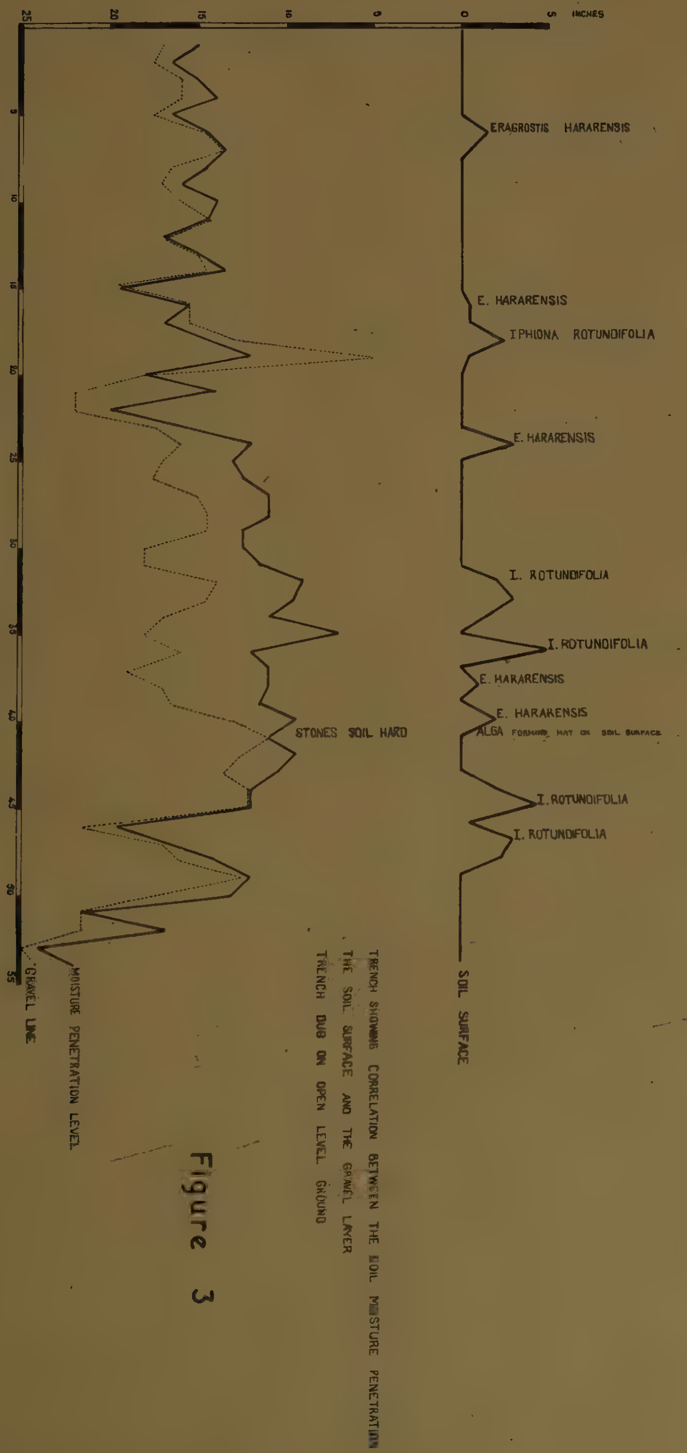
OPEN LICHEN AND ALGAL-COVERED SLOPING GROUND AT RIGHT ANGLES TO GENERAL GROUND SLOPE.



PIT Nos 3 AND 4

LICHEN AND ALGAL-COVERED SOILS NO COVER.
3 FLAT GROUND 4 SLOPING GROUND.

SOIL MOISTURE PENETRATION GRAPHS
GUBAN HAUD SUB-TYPE VEGETATION
GED DOBO MAY 23rd 1945



TRENCH SHOWING CORRELATION BETWEEN THE SOIL MOISTURE PENETRATION
THE SOIL SURFACE AND THE GRAVEL LAYER
TRENCH DUG ON OPEN LEVEL GROUND

Figure 3

MOISTURE PENETRATION GRAPHS
ANDROPOGON CYRTOCLADUS STAPF. "DUR" COMMUNITIES
JERIN AREA.
AFTER 1.5 INS. RAIN ON 10TH AUGUST 1945

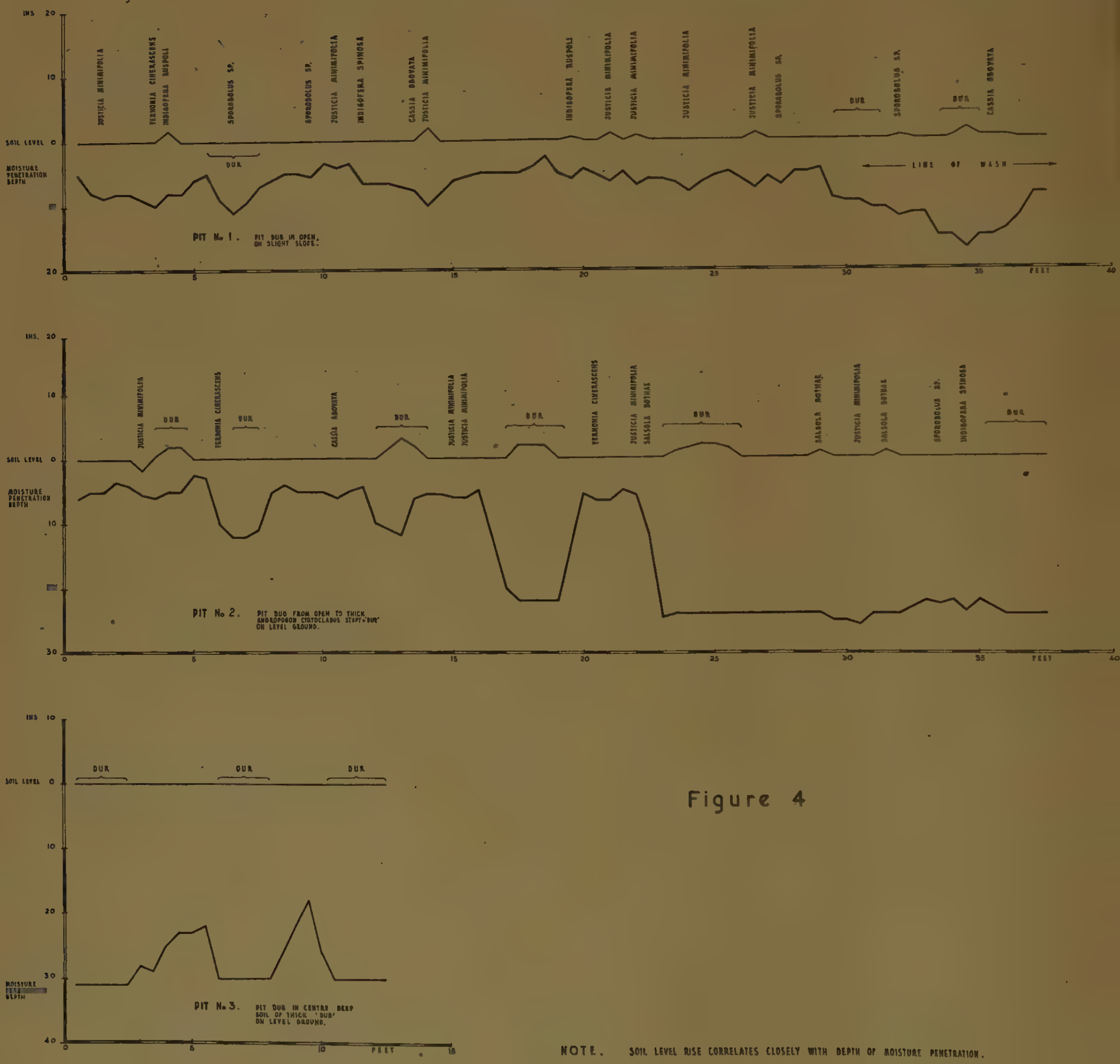
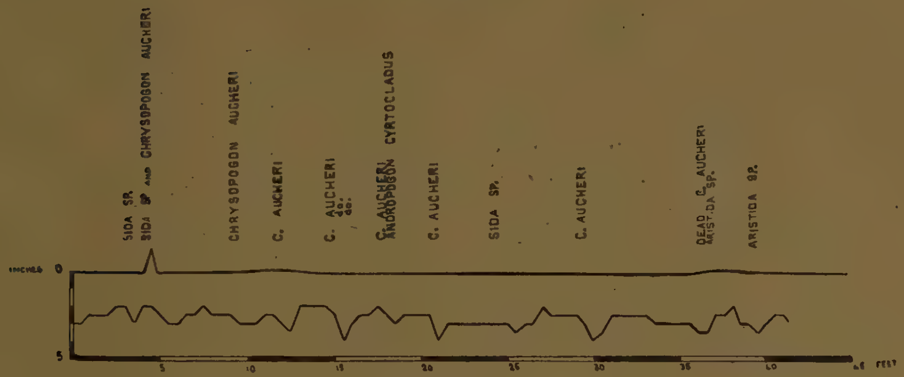


Figure 4

NOTE. SOIL LEVEL RISE CORRELATES CLOSELY WITH DEPTH OF MOISTURE PENETRATION.

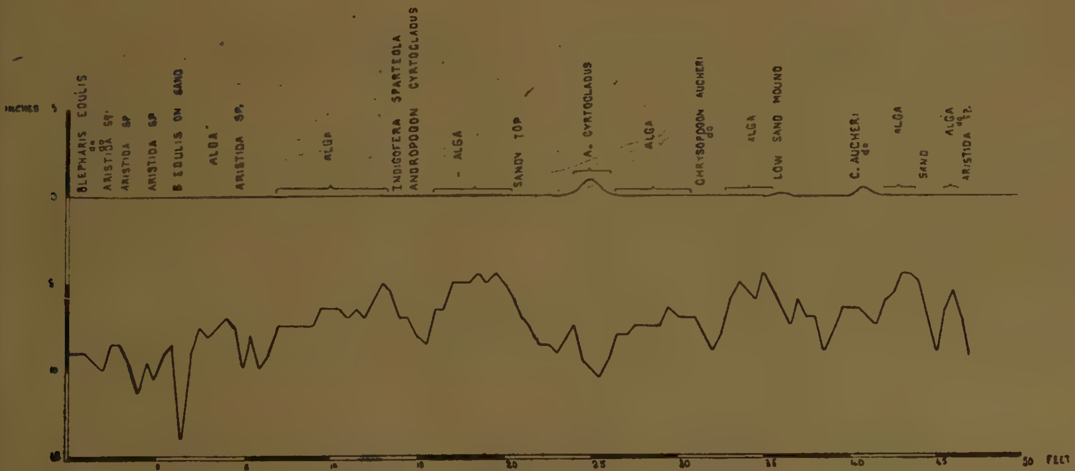
VISIBLE SOIL MOISTURE PENETRATION GRAPHS IN HAUD FIRE-RETARDED VEGETATION TYPE, ALABLA WADERE DISTRICT, SOMALIA, 1945

FIG. 5



GRAPH 1

Trench dug at 8.30 a.m. on 7-10-45 after .25 in. rain on open flat ground in yellow-red sandy soil overlying decomposing limestone on site of old burn.



GRAPH 2

Trench dug at 8.30 a.m. on 8-10-45 after .5 in. rain. Site as in Graph 1.

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THE PEASANT USE OF FERTILIZERS IN NORTHERN NIGERIA*

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In asking for a share in the limited world supplies of fertilizers we in Northern Nigeria are uneasily conscious that our claims may secure earlier recognition than those of territories whose needs are perhaps more acute. We are in the first place fortunate that our main agricultural export crop, groundnuts, has a well-assured market, and that it has been recognized, however belatedly, that unless we are to jeopardize the land reserves needed for a rapidly expanding population, an annual export of 300,000 tons of shelled nuts, containing 3,000 tons of phosphoric anhydride, cannot be maintained without the return to the land of an equivalent amount of phosphatic fertilizer (17,000 tons of single superphosphate). We are doubly fortunate in being able to show that, thanks in part to a good system of rail and road transport and in part to a ready response by northern soils to very small applications of one of the cheapest phosphatic manures, the use of single superphosphate by the peasant farmer would, over the area readily accessible by motor transport, prove highly economic, both for staple foodstuffs and for export crops.

When fertilizer trials were interrupted by the last war it had already been established that the response of the soils of Kano and Katsina Provinces to superphosphate was of the same order as that shown by the soils of Zaria Province, where applications of 50 lb. superphosphate per acre had been found to give increases in yield equal to those obtained by the use of one ton of pen manure containing an equal amount of phosphoric acid [1]. It had also been shown at Kano that on the light sands of the main groundnut area a significant residual effect could be detected in the fourth year following treatment with superphosphate [2]. From the data then available it was possible to predict with some certainty to the Oilseed Commission of 1946 that on average soils, with a yield of 800 lb. or less of groundnut kernels per acre, an application of 50 lb. superphosphate per acre would produce an added yield of 200 lb. kernels. At present prices superphosphate powder (18.5 per cent) can be landed in Kano at £20 per ton. This happens to be the current price for groundnuts. The farmer may therefore expect a fourfold return on his expenditure on fertilizers.

A further increase in the farmer's margin of profit was promised; first by the use of the more concentrated phosphatic fertilizers which would bear a lower transport charge per unit of phosphoric acid, secondly by the adoption of placement technique to ensure full benefit from the use of small applications. Since the resumption of fertilizer work in 1947 a number of experiments have been made with various types of phosphatic manure to find a method of placement which the peasant farmer is likely to adopt.

Fertilizer Powders

Considerable danger attends the use of neat fertilizer powders in unskilled hands, particularly with groundnuts, which are sensitive to contact even with the less soluble fertilizers. It was thought, however, that if a safe fertilizer/soil ratio could be prescribed the farmer could be persuaded to mix one measure of fertilizer with a given number of measures of soil and apply the mixture to the planting holes by means of a standard ladle.

This method may still have practical application in the case of sorghum, with which super/soil ratios of 1/16 and 1/25 were found safe with applications of 50 lb. and 200 lb. superphosphate per acre respectively. It seemed unlikely to be of value in the case of groundnuts on account of the large volume of mixture which the farmer would need to carry. A 1/30 super/soil mixture caused set-back at 50 lb., and a 1/55 mixture depressed early growth at 200 lb. superphosphate per acre. For the more soluble fertilizers a much wider ratio is required; sulphate of ammonia retarded early growth when applied at the rate of 25 lb. per acre in a 1/400 mixture.

Powder/soil mixtures have, therefore, not been given extended trial. The results of a series of field experiments made in Zaria, Kano, Katsina and Bauchi Provinces in 1947 are of interest since at Kano, where the stand-dosage of superphosphate (1.2 to 4.8 gm.) was mixed with a 4 in. cash-bowl of soil (about 250 gm.) and applied to the planting-holes of groundnuts a significant increase due to 50 lb. superphosphate was for the first time recorded on land with a non-manured yield of over 1,000 lb. kernels per acre. [No manure = 1,216 lb.: 50 lb. super = 1,431 lb.: 100 lb. super = 1,501 lb.: 200 lb. super = 1,386 lb. Sig. diff. 1 per cent = 197.]

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* Paper read to the Conference Internationales des Africanistes de l'Ouest No. III at Ibadan, Nigeria, on 14th December, 1949.

A parallel Kano experiment with sorghum in which the stand-dosages of superphosphate (2.4 to 9.6 gm.) were similarly diluted with 250 gm. of soil is quoted on account of the notable residual effect shown by groundnuts in the two following years. In this trial the super/soil mixture was applied in two ways:—

(*a*) Placed in the planting-hole immediately before planting.

(*b*) Spread in a thin line along the mid-point of the ridge prior to planting.

TABLE I

Treatment	Manured, 1947		Residual, 1948		Residual, 1949	
	Sorghum Grain (*lb. acre*)		Groundnuts Kernels (*lb. acre*)		Groundnuts Kernels (*lb. acre*)	
No Manure:—	*746*	*Diff.*	*834*	*Diff.*	*492*	*Diff.*
Super 50 lb. (s)	899	+153	1,068	+234	610	+118
„ 50 lb. (c)	1,117	+371	1,227	+393	680	+188
„ 100 lb. (s)	1,098	+352	1,200	+386	665	+173
„ 100 lb. (c)	1,123	+377	1,062	+228	641	+149
„ 200 lb. (s)	1,137	+391	1,275	+441	642	+150
„ 200 lb. (c)	1,141	+395	1,195	+361	610	+118
Sig. Diff. 1%	—	306	—	138	—	117
5%	—	227	—	102	—	87

Pelleted Fertilizers

The Groundnut Mission (1947) visited Nigeria shortly after the above experiments had begun. They were fervent advocates of placement technique and encouraged us to make up the stand-dosages of various types of fertilizer into pills which could be placel with the seed. They promised help in obtaining pills for large-scale trials should the method promise success.

Preliminary trials in 1947 with spherical pills made locally from superphosphate, triple super and monammonium phosphate showed that they could be safely placed by only slight modification of local methods of planting. Field-tests of commercially made pellets (aspirin-type) were then made with groundnuts in 1948, when 63 farmers gave a first trial to pellets of triple super and single superphosphate containing binding material. In the present year commercial and local types of pellet have been used in experiments with groundnuts, sorghum and cotton. At each of nine centres superphosphate pellets have been issued to permit 44 farmers to carry out trials with both sorghum and groundnuts. It was intended that with both crops comparative tests of locally made low-pressure tablets and imported high-pressure pellets should be made. The late arrival of the pellets has at many centres limited their use to groundnuts only.

Details of these experiments will be presented elsewhere. The main conclusions likely to influence peasant acceptance of fertilizers are given below.

Type of Fertilizer

Trials have been made with bone phosphate, single super, triple super monammonium phosphate and triple super-ammonium sulphate. The outstanding result with groundnuts has been the superiority of single superphosphate over the other manures. It has produced plants with conspicuously greener and more abundant foliage and with a significantly higher kernel yield. The following experiment, made at Samaru (Zaria) in 1948 with high-pressure pellets giving 11 lb. P_2O_5 (60 lb. single super) per acre at a spacing of 9 in. by 3 in. is typical of many others.

TABLE II

Treatment	Kernels (*lb. acre*)		Dry Haulms (*lb. acre*)	
No Manure:—	*1,200*	*Diff.*	*1,216*	*Diff.*
Bone phosphate	1,342	+142	1,253	+37
Triple super ..	1,448	+248	1,273	+57
Amm. phosphate	1,467	+267	1,246	+30
Single super ..	1,571	+371	1,681	+455
Sig. Diff. 1% ..	—	149	—	231
5% ..	—	113	—	173

Yields from manured plots are means for two methods of placement, dibbling and "toe and heel". The difference of 104 lb. kernels between super and ammonium sulphate is significant at 5 per cent. (Sig. Diff. 5 per cent = 94 lb.)

This finding is of some interest. Experiments made in the same year at Kontagora, where nitrogen dificiency is more pronounced than at Samaru, indicated that soluble calcium (gypsum) had a pronounced stimulartory effect on nitrogen fixation. Experiments to find an optimum calcium/phosphate balance have been made during the present year at a number of stations.

The practical significance is obvious. For groundnut production single superphosphate must be preferred to triple super or ammonium phosphate unless a suitable source of gypsum can be found locally. We are advised by the Director of Geological Surveys that such an event is unlikely; lime applied to the soil or to foliage has not produced the effect shown by gypsum.

With sorghum, single super appears to have no direct advantage over triple super; ammonium phosphate has the most immediate effect. But an important consideration in manuring sorghum is the residual effect which will be passed to the groundnuts which are usually grown in the succeeding year. Hence it would in the first place appear advisable to use superphosphate for manuring sorghum as well as groundnuts; the possibility of using superphosphate containing added nitrogen, or monammonium phosphate containing added gypsum is being investigated.

Type of Pellet

High-pressure: various: no bonding material.—Pellets of pharmaceutical type made at stamping pressures of up to 30 tons per sq. in. Monammonium phosphate and triple super left no residue at Samaru (rainfall 35 in.), but an irregular shaped residue, 21 per cent of the original weight, was recovered at the end of the season from triple super pellets used in N. Katsina (rainfall 27 in.). Single superphosphate, tried in 1948 in Samaru only, left a friable residue, 53 per cent of the original weight. Only traces of soluble phosphate remained in any of the residues. Bone phosphate pellets remain unchanged in shape and the recoverable residue at Samaru was 85 per cent of the original weight.

Superphosphate: bonded with graphite.—The pellets retained their shape throughout the season and gave residues ranging from 45 per cent at Samaru to 70 per cent in N. Katsina; the residues contained only small amounts of soluble phosphate. Although these pellets contained the equivalent of only 9 lb. P_2O_5 per acre they gave a better performance than triple pellets yielding 11 lb. P_2O_5 per acre.

Superphosphate: cake: low-pressure.—Whilst the partial solubility of single super pellets appears not to detract from their immediate performance it is desirable that they shall disintegrate as completely as possible if a well distributed residual (calcium?) effect is to be obtained. The recovery of apparently unchanged pellets by the farmer has had a disturbing effect; he has assumed either that his application has been too lavish or that the pellets contain material unacceptable to the plant.

It was found that pellets rolled at hand-pressure from a superphosphate-water dough withstood handling well and broke down in water much more rapidly than the high-pressure pellets. One ton of low-pressure tablets was made for comparative trial with high-pressure pellets during the present year. They were made in the shape of 5 in. cakes milled so that they would break into 100 square tablets. It was thought that the issue of fertilizers in units which the farmer could recognize (one cake to cost 1d.) might reduce the chances of misappropriation during distribution. The local manufacture of cakes of this sort has possibilities; they are comparatively fragile and the cost of effective packaging might prohibit their manufacture overseas.

Pills: granules.—It has from the outset been difficult to obtain a firm estimate of the cost of pelleting fertilizers in large quantities. Two leading fertilizer manufacturers in the first place agreed that for orders of 1,000 tons or more the cost would probably be in the region of £8 per ton. This was accepted as a reasonable charge for the convenience of distribution and utilization in the early years of issue to farmers: at the same time it appeared that an equivalent type of pill could be made more cheaply locally. The milled cakes referred to above were made by hand-stamping at a cost of £7 per ton: this charge could greatly be reduced by the use of primitive machinery and would be even less if single pills or tablets were made. It has therefore been disappointing that the only quotation yet received for the conversion of 5,000 tons of superphosphate into stamped pellets is £20 per ton, a cost which would place pellets of this kind out of the farmer's reach.

It seems that the cheapest material available commercially will prove to be spherical pills prepared by a process similar to that used in making granules, provided that not too large a pill is required. Experiments are now being made in the production of granules of single superphosphate one-third of the weight of the stamped pellets (1.4 gm.) previously tried; three of the granules wil be used per stand.

Methods of Placement: Groundnuts

Random.—It was assumed that in the peasant practice the easiest procedure would be to drop two seeds and one pellet together into the planting-hole, afterwards earthing over with the foot. Spacings likely to arise from this practice were tested. It was found that direct lateral contact of seed and spherical pills led either to inhibition of germination (ammonium phosphate 9 lb. P_2O_5 per acre: triple and single super 18 lb. P_2O_5 per acre) or retardation of early growth (triple and single super 9 lb. P_2O_5 per acre): a lateral separation of ½ in. was found safe. On dropping two seeds and one pellet from knee-height 12 per cent of the seeds fell within ½ in. of the pills.

Similar results were obtained in field trials with pellets (11 lb. P_2O_5 per acre). Pellets placed in the same horizontal plane as the seed gave equally high increases in yield whether separated by ½ in. or 1½ in. from the seed. Where two seeds and one pellet were dropped together into the planting-hole stand-counts made on the ninth day showed a significant germination lag due to both single and triple super. (*Percentage germination*: No manure = 88.9: bone phosphate = 88.6: single super = 78.6: triple super = 76.4: Sig. diff. 1 per cent = 9.0.) Although in this trial both triple and single super after normal supplying gave significant increments in kernel yield [+ 152 lb. (Sig. 5 per cent) and + 253 lb. per acre (Sig. 1 per cent) respectively, allowing 5 lb. seed for extra supplies needed over no manure (yield 811 lb.)], it was felt that random placement could not be recommended to the farmer. It is, however, possible that this is the only method he will readily adopt. Experiments are therefore being made to find the effect of direct contact between seed and the smaller granules, and to determine the distribution resulting from the dropping of three granules and two seeds into the same hole.

Toe and heel.—By first dropping the pellet and lightly earthing over before dropping the seed it was found easy to avoid contact between the two. The method recommended for the 1948 demonstrations was—

(*a*) hole scraped with bunched toes;

(*b*) pellet dropped into hole and lightly earthed over;

(*c*) pellet trodden downwards and forwards by ball of heel, leaving a heel-mark slightly behind the pellet;

(*d*) seeds planted in a heel-mark, earthed over and trodden down.

Ths method offered fair precision, only 2 per cent of seeds falling within ½ in. of the pellet. In field trials it gave increased yields equal to those obtained by accurately dibbling the seed 1½ in. from the pellet. Thus the mean increase in kernel yield per acre due to pellets of bone phosphate, single super, triple super and ammonium phosphate (Table II) was:—dibbling = +234 lb.: toe and heel ≏ +280 lb.

In practice it was found convenient for one person to drop the pill and for a second to plant the seed in the heel-mark made by the first. Farmers who tried this method in 1948 were almost unanimous in its condemnation. There is a peak demand for labour at the time of planting groundnuts which closely follows the planting of grain crops and coincides with their first weeding, or in bad years with their replanting: there was a just complaint that two lots of groundnuts might have been planted in the time taken to plant seed and pellet separately.

Dibbling.—The use of a spacing dibbler had previously been advocated in Kano Province to encourage close-planting and to reduce bird damage. A three-pronged dibbler which makes a pellet hole 1½ in. behind the seed-hole and a second planting-hole 9 in. ahead of it has proved useful on moist soils; a modification which allows for the placement of one pellet centrally between two seeds has been used in seed-pellet spacing trials. Dibbling involves one operation more than the "toe and heel" method and is not likely to find favour with the farmer.

Dibbling pellet with seedling.—In most districts farmers inspect their groundnut farms and supply vacancies soon after germination. It was everywhere urged by farmers who tried out pellets in 1948 that this would be the proper time to apply pellets to groundnuts. A number of pot experiments had indicated that groundnuts make much later response to superphosphate than do sorghum or cotton and in 1948 it was shown in a field trial at Samaru

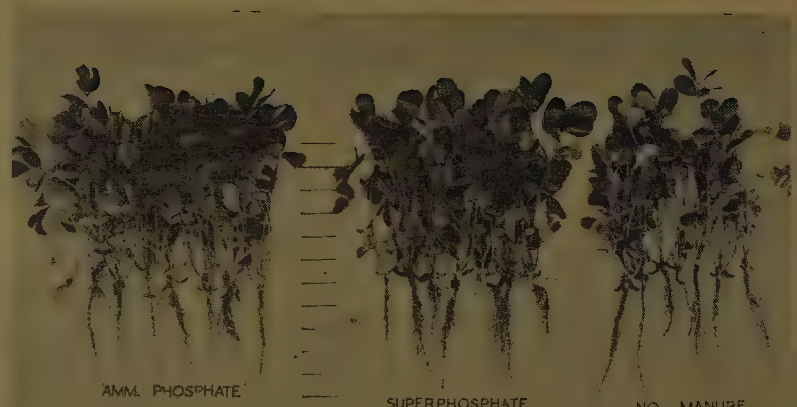

Fig. 1.

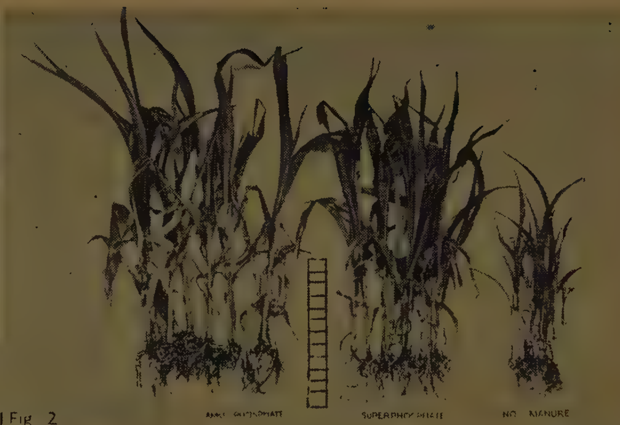

Fig 2

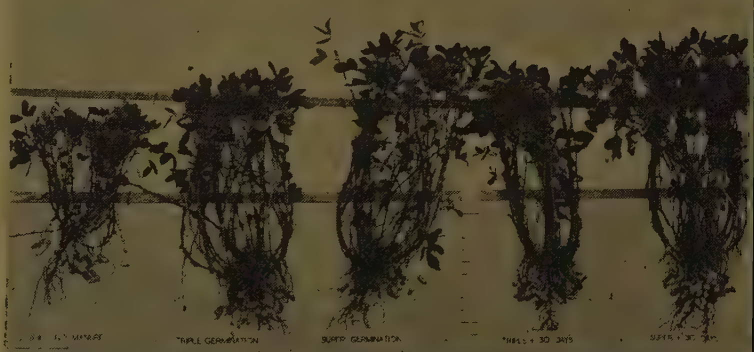

Fig. 3

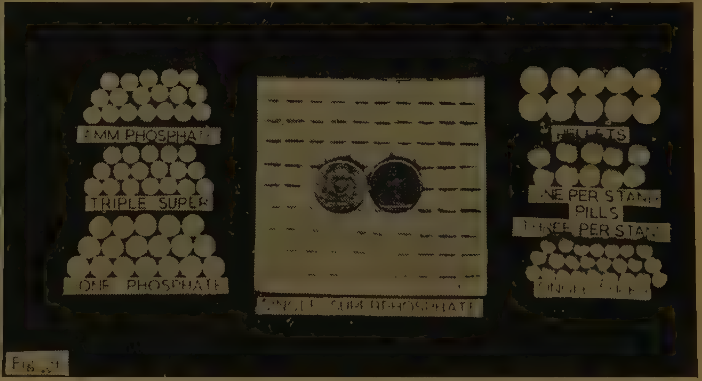

Fig. 4

FIGS. 1 AND 2.—Effect at 30 days of pellets of (i) monammonium phosphate, and (ii) single superphosphate equivalent to 11 lb. P_2O_5 per acre placed with seed of groundnuts and sorghum.

FIG. 1.—Groundnut var. Castle Cary: spacing 9 in. by 36 in. Mean wet weight (gm.) from L. to R.: (i) 10.33; (ii) 8.73; (iii) 6.46. ((i) and (ii) > (iii) at 1 per cent. No sig. diff. (i) and (ii).)

FIG. 2—Guineacorn var. Short Kaura: spacing 27 in. by 36 in. Mean wet weight (gm.) from L. to R.: (i) 14.80; (ii) 6.45; (iii) 1.42. ((i) > (ii) and (iii) at 1 per cent: (ii) > (i) at 1 per cent.)

FIG. 3.—Effect at harvest (129 days) of (i) triple super pellet, and (ii) single super powder (11 lb. P_2O_5 per acre) placed with groundnuts 10 and 40 days after sowing.

L. to R. (lb. per acre):—

Kernels: 844; 1,176; 1,255; 1,199; 1,280. Sig. diff. 1 per cent = 179.

Haulms: 803; 1,054; 1,440; 1,019; 1,293. Sig. diff. 1 per cent = 204.

FIG. 4.—Types of pellets, pills and milled-cake used. All equivalent to 11 lb. P_2O_5 per acre at 9 in. by 36 in.

that single superphosphate powder and triple super pellets gave the same increases in yield whether applied 10, 20, 30 or 40 days after planting. [*Mean response to both fertilizers*: 10 days = +371 lb.: 40 days = +395 lb.: no manure = 844 lb. kernels per acre.]

With the seedling in sight fairly accurate placement is possible. From Bornu, where only one seed is normally used per stand and vacancies in a poor season may be high, it was pointed out that the manuring of seedling rather than seed would lead to a saving in pellets. Accordingly in this year's trials the farmer has been advised to push a pellet into the ground, to a depth of one inch, between one and two inches from the young seedling. Returns from farms so treated are not yet available, but the method has given excellent result at Samaru where it was made standard practice in this year's pellet trials.

Sorghum.

The same method has been adopted in farmers' trials with sorghum, with which, however, there are indications that an early phosphate effect is of much more importance than with groundnuts. No records are yet available to show the effect of the time of application of pellets on grain yields; a field experiment made during the present year failed as a result of insect damage to young seedlings. From pot experiments it appears unlikely that plants manured 20 days after sowing are likely to catch up plants manured at the seed stage, e.g.:—

TABLE III

Wet wts. (gm.) 12 plants Guineacorn (farafara) at 37 days.—Treated with pellets of single super and monammonium phosphate giving 11 lb. P_2O_5 per acre at: (1) = planting: (2) = 10 days later than (1): (3) = 10 days later than (2):—

No Manure:—	*31·3*	*Diff.*
Superphosphate 1 ..	106·8	75·5
,, 2 ..	81·0	47·7
,, 3 ..	42·7	11·4
Amm. Phosphate 1 ..	195·7	164·4
,, 2 ..	182·4	151·1
,, 3 ..	97·8	66·5

Sig. Diff. 1% = 70·2
5% = 52·1

Owing to uncertainty in this year's early rains, which in some areas caused sorghum to be replanted twice, the farmer has had less spare time than usual and there has been complaint that dibbling pellets around the seedlings is too laborious. Using pellets designed for groundnuts (9 in. spacing) 4 pellets are needed for a normal stand of sorghum (3 in. spacing); over-meticulous placement by demonstrators has probably exaggerated the labour required.

1950 Programme

There is little doubt that with sorghum random placement of pellet and seed will prove safe, and it is hoped to find before the coming season a reduced size of pellet which will prove safe with groundnuts. Negotiations are now proceeding for the manufacture of 1,000 tons of pelleted superphosphate for free issue in 1950, as the first step in an approved scheme which provides for the free issue of 1,000 tons of superphosphate per annum in each of five successive years. The sponsors of the scheme feel confident that at the end of this period farmers will, after repeated demonstrations of its value, be freely buying superphosphate in quantities commensurate with the phosphate now exported in the groundnut crop. The present local practice of growing groundnuts without manure after a manured grain crop appears to be a sound one, and it is probable that the best use to which fertilizers can be put is to apply them to the grain-crop, leaving groundnuts to exercise their proved capacity for picking up a residual effect. If this practice is followed we may safely expect increased groundnut production to be achieved without detriment to grain production and without making further demand on land reserves.

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THE TEMPERATURE OF ANIMALS

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The rate of production of heat and energy in an animal depends on the rate at which metabolic processes are taking place and this, as with chemical reactions generally, depends on temperature. Vertebrates are grouped as poikilothermal (cold-blooded) and homoiothermal (warm-blooded). In the former the body temperature varies with the environmental temperature and does not differ much from it (Dukes, 1942). In the latter group, which includes all the mammals, the body has its own inherent temperature level which, along with the rate of metabolism, is largely independent of environmental temperature: comparatively minor variations in body temperature may occur owing to the influence of climatic, physiological, psychological and pathological factors. The accurate balance between heat production and heat loss which is responsible for the nearly constant temperature of mammals, involves the co-ordination of the higher levels of the central nervous system (Evans & Hartridge, 1933). Approach of death is in many cases indicated by a low, or "collapse", temperature (Wooldridge, 1934).

HEAT SOURCES AND CONTROL

Body heat comes from three sources—from metabolism, from the environment and from the activity of the microflora in the alimentary tract, though the last-mentioned is relatively unimportant (Duckworth and Rattray, 1946). Heat is conserved within the body through insulation afforded by air trapped between the hairs of the coat (or clothing in man), by insulation provided by the fatty layer under the skin and the colour, nature and thickness of the skin and coat. When environmental temperature and activity are both moderate, heat loss is effected adequately through conduction, convection and radiation from the skin, through the evaporation of water with the air expired from the lungs, and through the evaporation of water transpired through the skin. There is also a comparatively trivial heat loss from extrusion of waste products. The nature and degree of the activity of the thermoregulating systems brought into play are governed by the metabolic rate on the one hand and by the environmental conditions on the other (Duckworth and Rattray, 1946), When heat elimination cannot be effected sufficiently rapidly by the means just mentioned, other mechanisms such as sweating, panting and even drivelling of saliva may get brought into play, in an endeavour to keep the body temperature within the optimum limits for the particular species, race, or individual concerned. Should the working of all the mechanisms still not suffice, body temperature rises above the normal and a condition of fever, better termed hyperthermia (Lush, 1928) results. This is a matter of considerable economic importance, especially in connexion with the deterioration which takes place in high grade cattle introduced from temperate to tropical climates. A considerable literature centres in this subject. [Bonsma (1940), Bonsma *et al.* (1940), Bonsma and Pretorius (1943), Daubney (1942), French (1940) (1941), Rhoad (1936) (1940) (1942).]

TEMPERATURE GRADIENTS

Duckworth and Rattray (1946) discuss the question of the heat exchanges which take place between the body of an animal and its environment with particular reference to the tropics. Heat exchanges are conveniently indicated by body temperature measurement, an increase reflecting a net gain of heat by the organism and vice versa. It needs to be borne in mind that there are temperature gradients within the body itself. Thus temperature is higher in an organ as metabolically active as the liver than it is, for example, in the rectum. Even in the rectum there is a temperature gradient. Kriss (1921) showed that in a cow's rectum, the temperature was 100.5° F. at a depth of four inches, but 101.6° F. at seven inches. Care must be exercised to ensure that the thermometer is long enough and is well and truly inserted (Wooldridge, 1934), so that the bulb is in contact with the rectal mucosa (Grant, Millar and Worden, 1942). If ballooning of the rectum takes place, the thermometer bulb is likely only to record the temperature of the contained gases and the temperature shown is likely to be too low. This also applies if the bulb is embedded in fæcal matter. Rectal temperature is treated as representative of the body as a whole.

DIURNAL RHYTHM AND OTHER CAUSES OF TEMPERATURE VARIATION

Most animals exhibit a diurnal rhythm in body temperature. That the magnitude of such variation might be greater under tropical than under temperate conditions is suggested by the findings of Rhoad (1940). Constancy of body temperature could only be attained if the rate of heat dissipation were at all times equal to that of its production or acquisition. During the day heat tends to accumulate and the body temperature to rise somewhat. After rest and sleep, when all excess heat has been eliminated body temperature is at its minimum (Brody, 1945), and is then characteristic. This is why it is only the early morning temperatures in most animals which have much comparative value. It needs to be borne in mind that the temperature level for thermoequilibrium may differ between individuals and races of a species as well as between the different species themselves. Even under temperate zone conditions, where environmental circumstances facilitate rather than impede heat dissipation, some degree of diurnal rhythm in the body temperature is usually manifested, so the rhythm appears to be an integral part of the body's economy and its incidence not entirely dependent on outside conidtions. Work of Clark and Quin (1947) on Merino sheep suggests that the efficiency of heat regulating mechanisms may be influenced by the diet and general body condition. Performance of physical work may send up body temperature (Wooldridge, 1934, Quinlan and Mare, 1932), so may excitement or struggling (Hornby, 1942, Burtt, 1946).

In young animals the temperature is usually higher than in adults (Evans and Hartridge, 1933) and varies to a greater extent (Hornby, 1942). Overcrowding may impede heat loss so that the early morning rectal temperature in such cases may be considerably above what is normal for the species concerned. (Personal communication from H. E. Hornby.) It seems remarkable that, although the effect of overcrowding of animals is generally accepted by veterinarians, no mention of it seems to occur in text books or papers concerned with animal temperature. Temperatures in animals may differ according to their sex (Dukes, 1942, Evans and Hartridge, 1933), and according to the stage of the œstrous or menstrual cycle (Halbrecht, 1945). Normal temperature is raised slightly after a meal, during rumination, lactation or in pregnancy (Wooldridge, 1934). The best thermoequilibrium occurs in animals which can sweat freely, notably in man and horse (Hornby, 1942). Animals with dry skins are less well equipped. Thus whereas the diurnal variation in man may only amount to about one degree Fahrenheit, the difference in healthy camels may be as much as 6° F. between 7 a.m. and 7 p.m. (Leese, 1927). Under conditions of stress the thermal regulating system may break down and fail to prevent rise in body temperature beyond what is normal. (Regan and Richardson, 1938.)

THE RANGE IN THE EARLY MORNING TEMPERATURE IN MAMMALS

The range in the early morning temperature in non-hibernating mammals, considered as a whole, appears to be about 10° F. Thus Leese (1927) states that in resting camels it may be as low as 94° F., in an antbear (*Orycteropus afer*) it was 95° F. (Burtt, 1946); by contrast, sheep in Great Britain range from 102° F. to 104.2° F. (Ironside, 1943, Boddie, 1944); rabbits range from 101° F. to 104.2° F. (Dukes, 1942) and pigs from 98.3° F. to 104.8° F., with young pigs up to 50 days old, 1.5° F. higher than adults (Deighton, 1935). Records of early morning temperature of non-domesticated animals seem to be scanty. A few such observations are given by Vanderplank (1941).

THE EFFECT OF ATMOSPHERIC CONDITIONS ON TEMPERATURE

The rate of evaporation as indicated by the saturation deficit might well be expected to play an important role in influencing an animal's temperature. Duckworth and Rattray (1946), however, discussing thermoequilibrium in animals in the wet tropics, draw attention to work of Mitchell and Hamilton (1936), and Leitch and Thomson (1944) which does not give support to this view. The only other mention known to the writer that the evaporation rate needs to be considered in connexion with investigation of body temperature in animals is in the paper by Regan and Richardson (1938). It would seem that this is a matter which merits considerably more attention than has yet been given to it.

Many workers have shown that for certain domesticated species, there is a direct correlation between the daily rise in body temperature and rise in air temperature. Manresa and Gomez (1937) showed this for cattle in the Philippines, Minnet and Sen (1945) for buffalo, cows, goats and sheep in India, while Bonsma *et al.* (1940) showed it to be the case at over 80° F. for all exotic beef breeds in South Africa. The early morning rectal temperature may differ at different seasons according to the mean air temperature. Minnet and Sen (1945) showed this in relation to domesticated species in India, Manresa and Falcon (1939) in cattle in the Philippines, Sadiq (1943) in goats in Lahore, and Leese (1927) in camels. In the latter, the temperature ranged from 94° F. to 98° F. in the cooler season and from 95° F. to 99° F. during the very hot weather. Minnet and Sen sum up the position by stating that it can now be taken as a well known fact that air temperature, both diurnal and from season to season, influences the body temperature in animals. However, this apparently does not apply to all animals, since Deighton, for example, affirms that variation in temperature in the pig is independent of environmental temperature, or of the season of the year.

SUMMARY

The speed at which metabolism can take place in an animal depends on its body temperature. In cold-blooded (poikilothermal) animals this depends on the temperature of the environment, while in the warm-blooded animals (homoiothermal) it is largely independent of it. Sources of heat and the means by which the excess is eliminated as well as the causes of temperature variation in mammals are discussed. The characteristic early morning temperature in a species is that which indicates that all excess of heat has been eliminated. The range of early morning temperature which occurs in non-hibernating mammals is about 10° F. Body temperature in most animals is slightly influenced by climatic conditions.

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THE EFFECT OF LIME ON A CHLORIS GAYANA LEY

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At the beginning of 1948 the Uganda Veterinary Department took over some 200 acres of rough grazing as an extension to the Livestock Experiment Station at Entebbe. This land, situated on the end of the Entebbe peninsula, is a poor, light, sandy-loam, low in phosphates and potash and with a pH range of 4.5 tto 4.8. The grazing consists mainly of *Loudetia Kagarensis* which, though palatable, has a very low stock carrying capacity. *Hyparrhenia* and *Eragrostes* spp. are found but these are confined to the edges of main tracks and old termitaria.

It was with the intention of improving the carrying capacity of this area that trials were begun consisting of (i) top dressing to the existing grazing with from two to five cwt. per acre of rock phosphate, soda-phosphate and wood-ash, and with lime at the rate of three tons per acre, and (ii) ploughing up existing grazing and re-seeding with *Chloris gayana* both with and without applications of lime at the second ploughing.

The natural grazing showed no response to the applications of phosphate or wood-ash but the grass on the limed plots came away a little quicker following burning. There was no change in herbage composition of any of the plots.

The response of the chloris seeded ley to applications of lime (ploughed in) has been so marked that it has been suggested that the preliminary observations, made on three trials, may be of interest to others concerned with grassland improvement.

The first trial (A) consisted of a one-acre observation block of four ¼-acre plots. This block was first ploughed in May, 1948, and left fallow until July when two of the plots received a dressing of lime at the rate of four tons to the acre. The block was ploughed again and, following the preparation of a seed bed, *Chloris gayana* was sown three weeks later.

The difference betwen the germination of the *chloris* on the treated and untreated plots was most noticable, the chloris on the former coming away some 12 days earlier, and giving a denser and much more even stand. Later, when seeding had begun (16 weeks after sowing), the limed plots produced a practically pure stand as compared with a very sparse chloris growth with many bare patches and encroachment by inferior grasses and weeds on the plots which did not receive lime. The block was close-grazed in January, 1949, since when it has been left for seed.

In order to have some measure of the extent of the improvement observed, grass samples were cut from each plot and weighed.

The method of sampoing used was that of making three random casts in each plot with a 42 in. diameter hoop. At each cast the herbage falling within the perimeter of the hoop was cut at approximately one inch from the ground, air-dried for 48 hours and then weighed. The weight in grammes per cast gives a direct figure for the weight in pound per acre.

The weight of random cuts from trial A, taken twelve months after sowing, are given in Table 1. The photograph (fig. 1) of the samples cut gives a visual comparison of the differences in yield between treated and untreated plots. Comparison of the figures confirm that the initial superiority of the chloris on the limed plots has been maintained.

A second trial (B) designed to corroborate the observations made on trial A was begun in January, 1949. A two-acre block, running parallel to the original experiment was first ploughed in January. The block was then divided into 30 equal plots, 10 of which received lime at the rate of four tons to the to the acre at the end of February, treated and untreated plot running alternately throughout the block. The whole block was given a second ploughing and chloris was sown at the end of April.

Once again the superiority of the germination of the chloris on treated plots was well marked. It commenced seeding 18 weeks after sowing and random grass cuts were taken from 16 plots (four plots were discarded because of the presence of termitaria) and comparison beween the weights of air-dried grass from treated and untreated plots (Table 2) shows a definite response in favour of treatment. That the response is considerably lower than that of the first trial is possibly due to the fact that 1949 was a bad growing year for most crops (the chloris came to seed a fortnight later than in the previous trial), and weights recorded from a second cut taken 16 weeks later would appear to confirm this (Table 3). A statistical analysis of the results obtained from this trial shows a significant response to lime ($P = 0.05$).

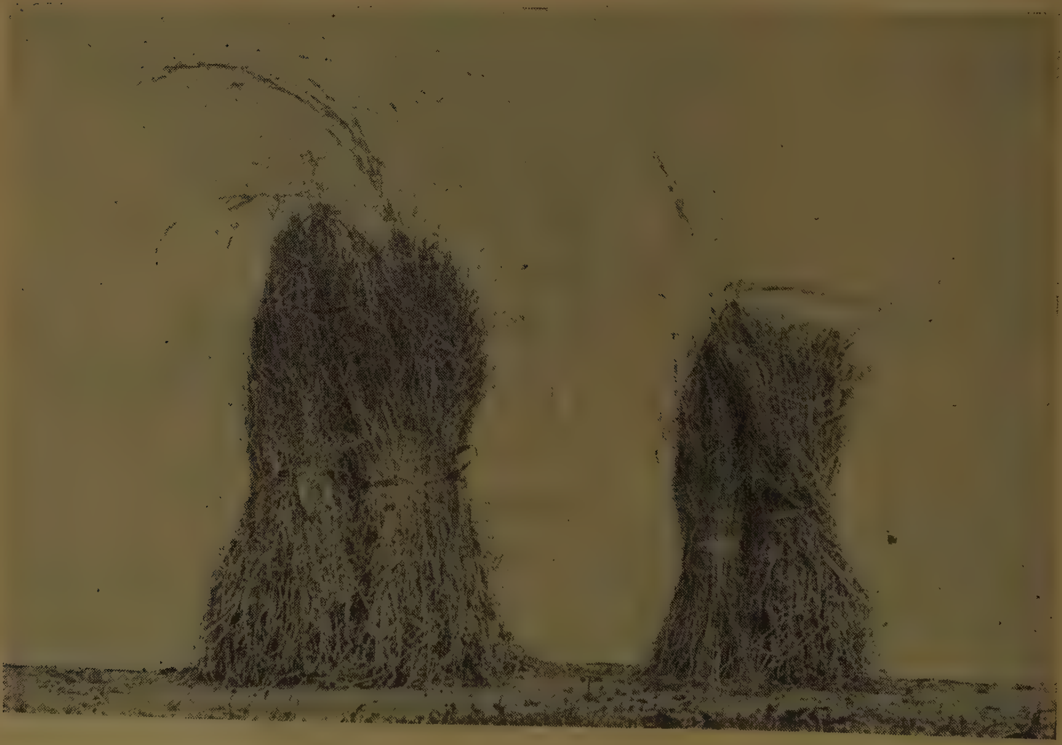
Soil analysis, as determined by rapid tests, showed that the pH range had been raised from 4.5-4.8 to 5.9-6.6 and that there was no effect on phosphate or potash.

In February 1949 a third trial (C) was begun, in which dressings of lime varying from 0 to 20 tons per acre were applied. A block of 12 1/15-acre plots was first ploughed in February and lime was applied at the rate of 2, 8, 10, 15 and 20 tons per acre at the second ploughing in May. Each treatment was replicated and the two remaining plots were untreated.

In this trial, visual comparison revealed the same difference between treated and untreated plots as that noticed in the earlier trials. The dressing at the rate of two tons per acre appeared to give similar germination to that on the plots which had received the heavier dressings and a fair cover was formed. It did not produce anything like the quantity of grazing and the cover did not improve to the same extent. For all practical purposes there was little to choose between the stands of grass produced by dressings of from 8 to 20 tons. Random sample cuts were taken when the chloris commenced seeding (14 weeks after sowing) and the plot yields are given in Table 4. Fig. II gives a visual record of the samples weighed.

TRIAL A

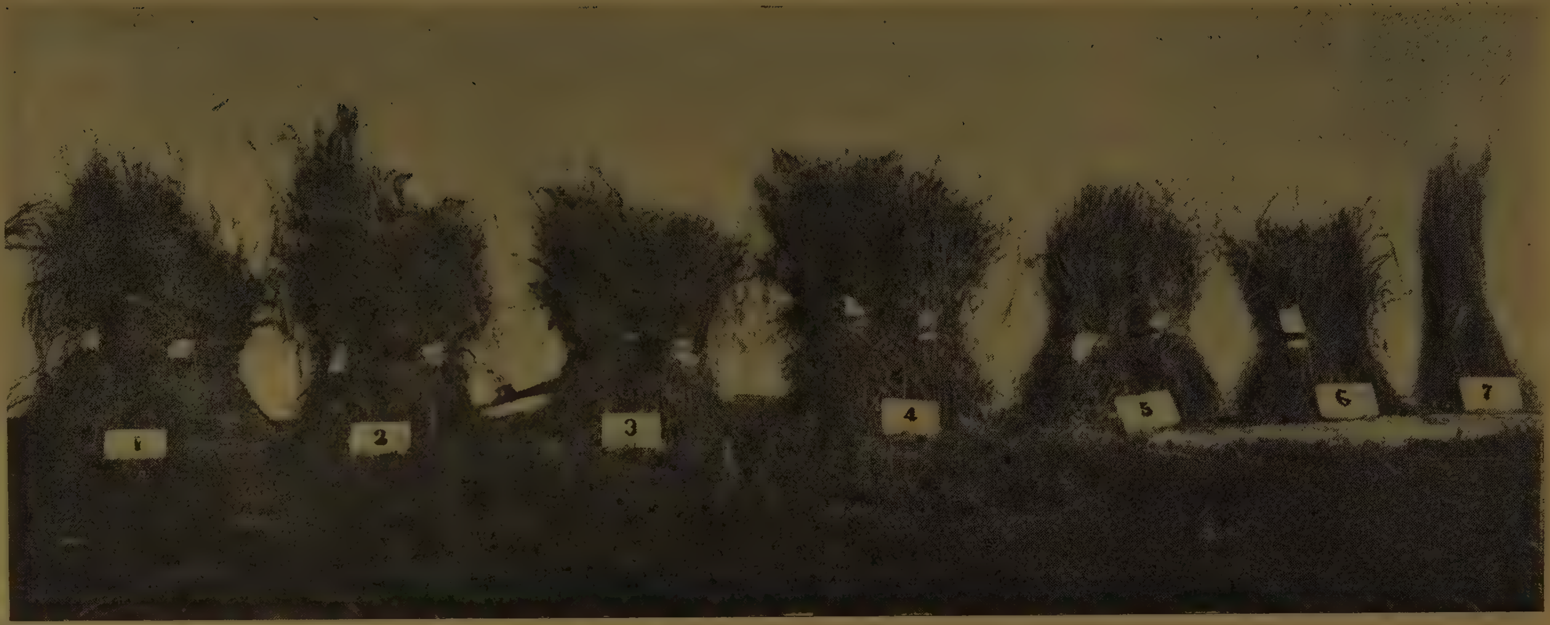
FIG. I



LIMED UNLIMED

TRIAL C

FIG. II



1. Limed 20 tons per acre.
2. Limed 15 tons per acre.
3. Limed 10 tons per acre.
4. Limed 8 tons per acre.
5. Limed 2 tons per acre.
6. Unlimed.
7. Natural grazing.

Unfortunately, statistical analysis was rendered difficult in this trial by the applications not being in a constant progression, but a least square solution of the results, though not statistically significant, indicates an optimum level of about 13 tons per acre.

It is relevant here to note that D. Meredith, in his publication "Fertilizing Grasses in South Africa", referring to one of the sown pasture experiments at Frankenwald (*Chloris gayana*—*Paspalum dilatatum* mixture) observes that "Rhodes grass (*Chloris gayana*) also responds well to applications of lime and seems to be more persistant on limed soils".

That *Chloris gayana* is, at present, the only grass of proved grazing value which can be easily established from seed, together with the fact that there is an abundant supply of seed from a good variety (Teso) is sufficient justification for further research as to the best means of establishing chloris leys, these being of the greatest value in raising the productive capacity of much of the intensely cultivated areas around the larger townships.

There seems little doubt that applications of lime on the lines indicated in these trials could prove a valuable means of establishing these leys, though with lime at its present price it is not suggested that this is economically possible.

The true assessment of what will constitute an economic price for lime, apart from the more obvious item of supply and demand, must necessarily await the results of more detailed long-term experiments (one of which has already been begun under the direction of Dr. ap Griffith) designed to obtain proof or otherwise of its long-term value, mode of action, effect on following crops, etc.

An equally important feature of the trials is, in the writer's opinion, the proof that, contrary to views held by many, significant improvements can be obtained from the use of lime in this country.

I wish to record my thanks to the Director of Veterinary Services for permission to publish this paper, to Dr. ap Griffith for his assistance with soil samples and many helpful suggestions, to Mr. H. Manning for undertaking the statistical analysis, and to Mr. Ward of the Public Relations Photograph Department.

TABLE I (TRIAL A)

TREATMENT	LIMED	UNLIMED	% INCREASE
Number of samples	6	6	—
Number of plots	2	2	—
Average yield in lb./acre	363·0	210·8	72·2

TABLE II (TRIAL B)—1ST CUTTING

TREATMENT	LIMED	UNLIMED	% INCREASE
Number of samples	24	24	—
Number of plots	8	8	—
Average yield in lb./acre	253·7	198·1	28·6

TABLE 3 (TRIAL B)—2ND CUTTING

TREATMENT	LIMED	UNLIMED	% INCREASE
Number of samples	22	22	—
Number of plots	8	8	—
Average yield in lb./acre	667·3	411·9	61·7

TABLE IV (TRIAL C)

TREATMENT	Lime 20 tons	Lime 15 tons	Lime 10 tons	Lime 8 tons	Lime 2 tons	No Lime	Natural Grazing
Number of samples	6	6	6	6	6	6	6
Number of plots	2	2	2	2	2	2	2
Yield in lb./acre	555·0	657·3	559·1	618·8	395·8	255·3	91·6
Percentage response cf no lime	117·3	157·4	118·6	146·2	55·0	—	—

A NOTE ON SOIL CLASSIFICATION BY A NATURALIST

By A. P. G. Michelmore

(*Received for publication on 28th January,* 1950)

An outsider notes an air of frustration and futility amongst certain pedologists, when the classification of tropical soils is mentioned. There seems to be a feeling, that a soil survey is so laborious as to be impracticable in backward countries, and further, there is a doubt whether the data collected by survey can lead to a rational classification. Some even wonder whether a classification would really mean anything or have any value. If pedologists cannot yet give a decision from the internal evidence of their science, a stranger to the subject may be forgiven for bringing some external evidence to bear. The last difficulty will be dealt with first.

The Value of Soil Classification

With tropical populations increasing and productivity often decreasing, man is now concerned with fertility more than ever before. If the pedologist cannot classify soils, every single plot of land has its own separate fertility problem, which can only be solved by trial and error on that one plot. On the other hand, if a natural classification can be devised, experience in one place can be used at once in other places with the same type of soil, and can be applied with modifications on related soils, if allowance is made for any differences in climate. Soil classification is therefore needed to make the fullest use of existing knowledge, and to show where more research is most needed.

The reality of Soil Classification

In Africa, especially in the wilder parts, one is constantly struck by sharp changes in vegetation. These changes separate different vegetation types, which either cover large areas with little variation, or else keep on recurring in similar sites. Often these alternations of types are arranged in a regular catena according to the topography, all hilltops, all slopes and all valleys having each their special type. Sometimes local difference in climate can explain differences in the vegetation, as when fierce winds suppress certain forms on exposed hilltops, or occasional frosts prevent others from growing in enclosed hollows. More often, however, there is such a sharp difference between adjoining types, while each type exists in suitable sites over such wide areas, that local differences in climate cannot account for the differences in vegetation. In other areas the vegetation types are arranged in an irregular mosaic irrespective of the topography, so that again climate cannot be held responsible. Where disturbance by man and animals can be ruled out, soil defferences are left as the only possible explanation.

In some places a local change in vegetation type is obviously due to a change in a single soil factor, as where a line of evergreen trees fringes a watercourse running through country clothed with deciduous woodland. Even the untrained eye can usually see that the change in vegetation follows a distinct change in soil type. Sometimes the soil difference is less obvious, but the distribution of the vegetation types, and analogy with other instances, suggest that there is one.

It has already been mentioned that the different types of vegetation met in any one area are seldom confined to that region. They usually spread far and wide on suitable sites in different directions. Over its whole range a type may vary to some extent either through the influence of a somewhat different climate, or through a minor variation of the soil type below it, or through replacement of certain plants by other related species in a different floristic region. In spite of these variations, many vegetation types retain their individuality over wide ranges.

In a certain area in the southern tropics two different types, A and B, may occur side by side. Type A may extend, in the form of its variant, A1, five hundred miles to the south, type B may stretch five hundred miles north, varying slightly to B1, and may even skip the equatorial belt and reappear in the northern tropics as variant B2 on suitable sites fifteen hundred miles away. Yet in Africa it would be easy to find instances where in a hundred yards one could walk out of type A into type B and see far greater differences than between A and A1, five hundred miles apart, or even between B and B2 much more widely separated.

It is impossible not to believe that the sharp change from A to B is due to an important soil difference, and that the soil under A1 is usually essentially similar to that under A, and those under B1 and B2 to that under B.

Ecological Survey

Most of Africa consists of very ancient land surfaces. Their age has allowed soil differentiation to go on for a very long time, so that the products of one parent rock have diverged into very different soils, according to their position in the topography. As the soils have developed, so has a characteristic vegetation type developed on each. The vegetation of the ancient African plains and plateaux is likely to be a better index to soils than that of younger countries like Britain.

It seems that pedologists are by no means agreed as to the criteria to be used in classifying soils. Since there is no difficulty in classifying and surveying vegetation, it would seem that the best approach would be through vegetation survey, which itself serves other purposes also.

The vegetation classes to be used in survey must be chosen carefully and during the course of field work in the survey area. Classification by the form alone of the vegetation may be misleading. For instance, a category such as "Open, deciduous, broadleaf woodland with short, tufted grass", could include several types quite distinct floristically and growing on very different soils. The classification therefore must take account of the floristic composition of the vegetation as well as its form.

Although it is a valuable indicator, vegetation survey alone can never be a reliable guide to soils. An important vegetation type may occur on more than one type of soil in the centre of its range but may become specialized in its needs at the fringes. Certain types may be dependent on one special factor, such as water supply or salinity, and be able to range over a variety of soils, provided that this one factor is present.

The best form of survey is a full ecological survey, in which vegetation, soil and human activity are all recorded, together with any other information which may be useful. In a backward country the emphasis is laid on the vegetation part of the survey, this being the easiest to do and giving the most methodical results. The vegetation survey then forms a framework, on which to hang the observations on soils and land usage, which are then welded in to form a consistent whole. An example of the value of this approach, in showing the best lines along which to develop the different types of country and soil, is the work of the Ecological Survey of Northern Rhodesia [1], [2], [3].

Since local soil differences have such big effects on natural vegetation, they must affect cultivated crops also. A simple vegetation survey will allow these effects to be surmised; an ecological survey including existing agriculture will turn most of these surmises into certainties.

Classification of Soil Types

Ecological survey will map the soils of a region and help to define the different types, but it will not necessarily classify these types into major groups. The fact that some students of soils doubt the value of soil survey and classification, while ecologists, looking at the products of these soils, can classify these products usefully, suggests that soil classification may have been approached from the wrong angle. Is it a case of not seeing the wood for the trees? Perhaps the details of physical and chemical analysis of samples have sometimes obscured the broad principles of the processes of soil formation and their variations over wide areas. Possibly more extensive and less intensive work would help at this stage.

Some of the principles of soil formation already recognized by pedologists have much in common with the principles of plant succession. Soils could easily be classified on the sort of system by which ecologists classify vegetation types, especially on the comprehensive system devised by the late F. E. Clements in America [4], [5]. According to this system, plant communities are not grouped by their present appearance, but by their origins and genetic relationships. They are considered, not as fixed entities, but as being in a state of flux and development, till they come into equilibrium with their surroundings. (This is equally true of soils.) Any one region has a fully developed, mature type in equilibrium with the climate. This is called the climatic climax (which corresponds with a zonal soil). If the region has several very distinct soils, the climatic climax may be divisible into corresponding edaphic climaxes. (Similarly different parent rocks may support different soils within a climatic region.) Areas of immature soil bear corresponding immature types of vegetation, which tend to develop towards the climatic climax (as the soils under them also tend to develop). Certain areas may be prevented from reaching the climatic climax by locally unfavourable conditions and may never progress beyond one of the developmental types, which is then termed a sub-climax. (The same is true of soils.) A region bearing one climatic climax may also bear local outliers of the climaxes of the more and the less climatically or edaphically favourable regions on either side. The former will be on exceptionally favourable sites, the latter on unfavourable sites. (The corresponding condition in pedology is the local occurrence as intrazonals, in locally different climatic patches, or on unusually rich or poor parent rocks, of soils which occur as zonals in their respective normal climatic regions.) Sometimes such outliers are relics of a former different climate in the region. (So-called "fossil" soils correspond to this.) Vegetation types do not always develop to more complex forms but may become degraded, occasionally through their own intrinsic properties, but more usually on account of interference by man or a change of some physical factor. (Degradation of soils, particularly by man's interference, is common.) Vegetation, after serious interference or destruction may be able to develop again to its original form if left. Sometimes it and its environment have been so altered, that it can no longer revert but develops along a new set of stages to a different and so-called biotic climax. Continued interference may keep it permanently in one of these developmental stages. (Permanent alteration of soils through permanent or temporary interference is also not unknown.)

The idea that plant communities tend to develop has proved a great advance in ecology. The parallels just drawn in this very brief and imperfect summary show that soil systems and vegetation systems have much in common. It is therefore possible that a new genetic system of classifying soils might prove more natural and useful than present systems.

Anyone wishing to work out such a classification could study with profit the works of Clements, although he might not wish to coin quite so many new technical terms for his science. In place of "vegetation" and "soil" he would have to read "soil" and "parent rock".

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BOOK REVIEWS

THE AGRICULTURE OF THE CULTIVATION STEPPE, By N. V. Rounce. Published by Longmans Green and Co., Cape Town, 1949. pp. 105, not priced.

This book was written by a group of Agricultural officers who have worked for many years in the Lake, Western, and Central Provinces of Tanganyika. It is therefore an authoritative work, with opinions carefully weighed and data carefully checked. Most of the chapters were writtten by Mr. Rounce, but he has called upon others to record their observations in order that the best possible material will be available. It is almost a rarity for the experience of a group of agricultural officers to be made available to their successors, and great credit is due to Mr. Rounce for this record of the agriculture of a large area occupied by some two million African farmers.

There are 33 tables in 94 pages of the main text, which makes the book a work of reference rather than a general description, but anyone studying the agriculture of the area will want figures as well as observations.

D.W.D.

A SHORT HISTORY OF AGRICULTURE IN THE BRITISH COLONIES, By G. B. Masefield. Published by Geoffrey Cumberlege at the Oxford University Press, 1950. pp. 175, price 10/6d.

We are apt to think of tropical agriculture as a new science, and there is no doubt that scientifically it is in its infancy. But practical agriculture has been practised in the tropical colonies for many centuries, not only by the indigenous population but by European immigrants and their descendants. In this book Mr. Masefield gives an excellent review of the history of agriculture in the British colonies, not with the dry impartiality of the old-fashioned historian, but rather with the enthusiasm of the modern writer of historical novels.

The sugar planter, the tea planter, the rubber planter and the farmer will all benefit by obtaining a broader view of the rise of their particular branches of tropical agriculture, and they will find that the pioneers in every branch had to overcome difficulties which must have seemed insuperable at the time. Those who are only indirectly interested in tropical agriculture will obtain a bird's-eye view from this book: those who are directly concerned will find it fascinating reading.

D.W.D.

DRY-WOOD TERMITES

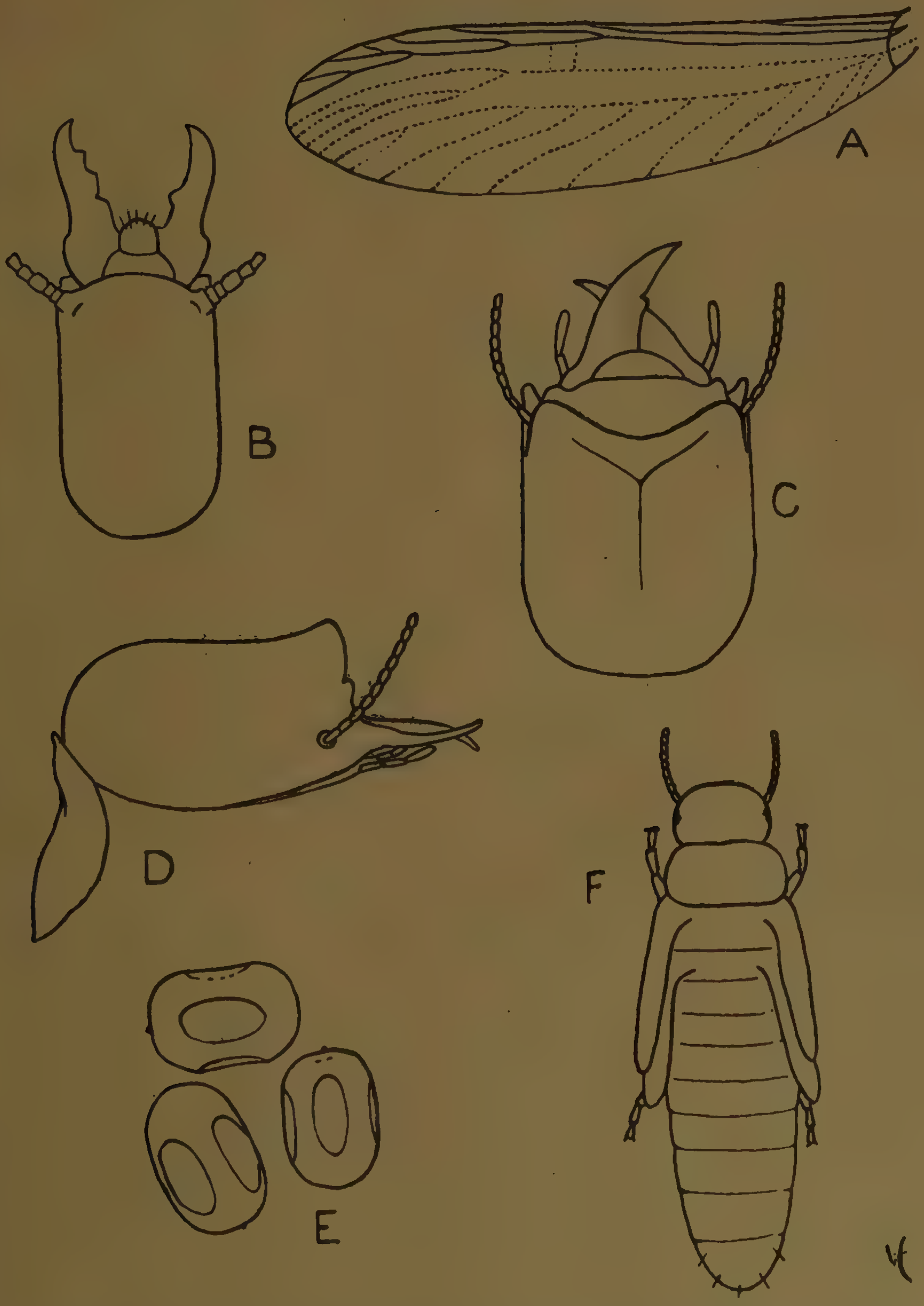
By W. Victor Harris, Officer in Charge, Colonial Termite Research

(*Received for publication on 2nd March, 1950*)

Dry-wood termites, unlike most of the termites in East Africa, make their colonies in dry wood and have no connexion whatever with the soil. Superficially their mode of life, and the damage they do, resembles that of the death-watch beetle and the pin-hole borers. The "wild" dry-wood termites are found living in dead branches and wounds of trees both native and introduced, while the "domestic" dry-wood termites inhabit buildings and furniture. As dry-wood termites are generally speaking more tolerant of cold weather than are the subterranean termites they have a wider geographical distribution; one species is found in Southern Europe, and a number in the U.S.A. One result of this is that they have been studied in greater detail than have the tropical termites, from whom they differ in many respects, and much that has been written about "termites" refers exclusively to them and not to those forms which are much more commonly found in East Africa.

Dry-wood termites belong to the family Kalotermitidæ, of which five out of the nine genera are represented in East Africa. These are the Cryptotermes, to which the domestic dry-wood termites belong, and the wild genera Kalotermes, Neotermes, Procryptotermes and Glyptotermes. They are more primitive than either the damp-wood or mound-building termites. A colony of dry-wood termites numbers at most a few hundred individuals as compared with the thousands and hundreds of thousands of the mound-builders. There is in each community a king and queen, and a small number of soldiers, but no workers. The bulk of the population is made up of nymphs who ultimately become winged males and females, but who are employed during their youth carrying out those duties which in the higher termites are done by the workers. Their diet consists entirely of dry wood, for the digestion of which they are dependent on the co-operation of a vast number of intestinal protozoa. These nymphs are pallid creatures. The soldiers, too, have pale bodies, but their gross heads are brown or almost black in colour. The shape of the soldier head and the large mandibles it bears provide a means of identification more readily available than the winged adults. (Fig. B). As they form only a small portion of the population, soldiers have to be sought for carefully in infested woodwork.

The presence of dry-wood termites is usually indicated by the presence of small heaps of frass or fæcal pellets, superficially like the frass made by furniture beetles, but proving on closer inspection to be of uniform size and distinctive shape, oval and seed-like. These pellets are pushed out from small holes on the surface of the woodwork, the holes being sealed up when not in use by plugs of pellets cemented with saliva. Inside the infested timber excavations are found to an extent depending on the age of the termite colony, ultimately there being only a thin outer shell supporting the layer of paint or varnish, with a few slender partitions inside. Domestic dry-wood termites will attack roof-members, ceiling and floor boards, door and window frames and the furniture of a house. Books and anything else they can find that contains cellulose will be destroyed by them. Heart wood and sapwood, plywood and veneers are all liable to harbour dry-wood termites unless they have been treated with termite-repellant chemicals. Paints and varnishes offer protection only if their coating is quite unbroken. Cracks and joints are common weak spots, and cases are recorded of doors becoming infested via the keyholes. The trouble starts with the arrival of a pair of winged termites, male and female, who discard their wings and seek out a suitable place for boring operations. Once inside the woodwork, the entrance hole is sealed up with fæcal pellets and there is no further sign of them until the colony has developed to the stage that they must tip their refuse outside. During this time the female has been busy laying eggs from which nymphs have been developing to carry on the work of the colony. When the swarming season arrives, many of the nymphs become winged adults and leave the colony, with the result that there is for a time a reduction in wood boring, thus producing an annual cycle of activity not to be found to such a marked degree in the higher termites whose wood-consuming activities are the work of a special caste. Although the population of a dry-wood termite colony is comparatively small, and can exist happily in a few cubic inches of timber, these termites achieve their high degree of damage by sheer weight of numbers of colonies.



Dry-wood Termites.—*Procryptotermes Jeannelanus,* wing A; head of soldier B; *Cryptotermes havilandi,* soldier head from above C; soldier head and prothorax in profile D; *Cryptotermes dudleyi,* fæcal pellets E; *Kalotermes durbanensis,* nymph F.

Cryptotermes haviland (Sjostedt), is present in Dar es Salaam in the timberwork of old buildings. The extent of the infestation is not known. It was first recognized about 1925 from specimens collected in the ceiling boards of an old house near the European Hospital. Twenty years later specimens were obtained from the same situation, as well as from a piano in the house. More recently damage has been reported in window-frames and ceilings of other pre-1914 buildings. There is one record of this termite from Mombasa. It has not been found out of doors in East Africa. It is widely distributed in West Africa from Senegal to the Congo, and is recorded from Madagascar and the Comoro Islands. Recently it has appeared in the Western Hemisphere, in Trinidad. It is regarded as an African species, but it is as yet too early to express any opinion as to the possibility of it having been introduced into East Africa.

Cryptotermes dudleyi Banks, is a dry-wood termite of Oriental origin recently identified from material collected some years ago at Tanga, where it was damaging stored Podocarpus timber. Though originally described from Panama, where it is now believed to have been introduced about 1890, it has been found over a large part of the Far East, including Ceylon, as well as in Northern Australia and South America. Before the possibility of such widespread distribution in dry-wood termites by the movement of infested timber had been fully appreciated, *Cryptotermes dudleyi* was described under no fewer than seevn different names from as many localities.

Cryptotermes brevis Walker, is mentioned here although it has not as yet been found in East Africa. It is a Central American termite, common in the West Indies, which has spread into the southern United States, and crossed the Pacific by way of the many islands and arrived in Hong Kong. It is considered one of the most destructive of all the termites. It has nowhere been found in the wild state, and is regarded as having become completely domesticated and associated with man. In 1921 a dry-wood termite was found in some furniture in a printing works at Durban. It was regarded as a new species and from its resemblance to the American species *brevis* was given the name of *pseudobrevis*. Twenty seven years later it was identified as *brevis*. In the meantime it had spread through the commercial centre of Durban out into the residential suburbs, and appeared in Port Elizabeth. Much money has already been spent in the replacement of timberwork in infested buildings and legislative measures have been introduced to try and check the spread of this pest to other parts of the Union. The menace of this, as with other dry-wood termites lies in the ease with which it can be carried long distances by man, complete young colonies being able to exist for months unsuspected in small pieces of timber, in packing cases, or in manufactured articles large or small.

The wild members of the Kalotermitidæ are not found in great numbers in East Africa, though they are widely distributed. They are of no particular economic importance, as compared with the domestic species, since they are restricted to dead branches and stumps of branches. It may be mentioned, however, that related species have become important pests in parts of the Orient. In Java *Neotermes tectonæ* damages rubber trees, while in Ceylon *Neotermes militaris* and *Glyptotermes dilatus* attack tea bushes. In these cases the termites start in dead branches or wounds which have not completely calloused over, but pass on to the living wood. The following is a list of the wild Kalotermitidæ recorded to date in East Africa:—

Kalotermes durbanensis Haviland. Tanganyika: Morogoro on *Anona* spp, Masasi on *Diplorhynchus* sp, Mafia Island on *Poincianna regia*.

Procryptotermes jeannelanus (Sjost.) Uganda: Kawanda on *Ficus natalensis;* Tanganyika: Kilimanjaro.

Neotermes cryptops (Sjost.) Tanganyika: Iringa on *Brachystegia edulis,* Ugalla.

Neotermes meruensis (Sjost.) Tanganyika: Ngare Nanyuki; Kenya: Athi River.

Neotermes firmus (Sjost.) Kenya: near Mount Kenya.

Glyptotermes parvulus (Sjost.) Uganda: Kawanda on *Poincianna regia, Xymalos monospora* and *Conopharyngia holstii.*

Of these six species two are recorded elsewhere; *K. durbanensis* from Natal, and *G. parvulus* from the Ivory Coast, the Gold Coast and the Belgian Congo.

PYRETHRUM WILT IN KENYA CAUSED BY SCLEROTINIA MINOR

By **R. M. Nattrass, Department of Agriculture, Kenya**

(*Received for publication on 6th June, 1950*)

A wilt and crown rot of pyrethrum is of common occurrence in the Highlands of Kenya. The fungi associated with the disease, *Fusarium graminearum* Schwabe, *Fusarium* sp., *Sclerotinia minor* Jagger and *S. sclerotiorum* (Lib.) de Bary, have previously been recorded (Nattrass, 1945). This note refers to the disease caused by *Sclerotinia minor.*

The first noticeable effect of the disease is a sudden wilting and drying up of the leaves. In the later stages of attack the *Sclerotinia* wilt can be distinguished from the *Fusarium* wilts by the somewhat bleached appearance of the dead parts of the plant. Among the bases of the shoots occur numerous small black, more or less spherical bodies about 2 mm. in diameter. These sclerotia start to form as white knots of mycelium which become hard and black on reaching full development.

Three months old pyrethrum seedlings growing in pots in a glasshouse were infected and killed when small pieces of an agar culture of the fungus were placed about half an inch below soil level and close to the plants. Within a month wilting occurred and the outer leaves were rotted. Six weeks after inoculation the plants collapsed. After being covered for two days with a bell jar, white fans of mycelium spread over the surface of the soil and sclerotia were beginning to form on the dead tissue.

The fungus, *Sclerotinia minor,* attacks a number of herbaceous plants. It is known as a disease of pyrethrum in Japan and of lettuce in North America. Lettuce plants have been inoculated and killed by the fungus obtained from Kenya pyrethrum plants. It has recently been found causing a wilt and stem rot of sunflower in Kenya.

With the breaking up of plants killed by the fungus a large number of sclerotia is released in the soil. These retain their vitality for long periods. Since they have no means of independent motion, the spread of the fungus is confined to the gradual extension of the mycelium from a diseased plant to an adjacent healthy one and by the transference of the sclerotia with the soil in the process of cultivation, by the movement of surface water, or by animals.

In dry soil the sclerotia remain dormant but with the right conditions of moisture and temperature active mycelium will grow out into the soil in search of another victim.

The allied fungus, *Sclerotinia sclerotiorum* with much larger sclerotia, has less frequently been found attacking pyrethrum in Kenya. These sclerotia produce a cup-like fruit body at the end of a short stalk which brings it to the surface of the soil. In this are formed spores, which can be airborne and thus greatly extend the range from any particular focus of the disease.

Although the sclerotia of *S. minor* have been kept for an equal period and subjected to the same conditions, no spore-bearing apparatus has been seen so that, as far as is known, only the sclerotia serve to carry on the disease in Kenya.

The sporadic occurrence of the disease suggests some contributory factor. This may be previous weakening by drought, faulty cultivation or unsuitable localized soil conditions. Prolonged wet with poor drainage probably favours the disease.

The conditions under which plants become attacked in the field are not known. They are largely beyond the control of the grower. A high incidence of the disease, however, naturally suggests the introduction of an alternate crop.

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FIG. 1

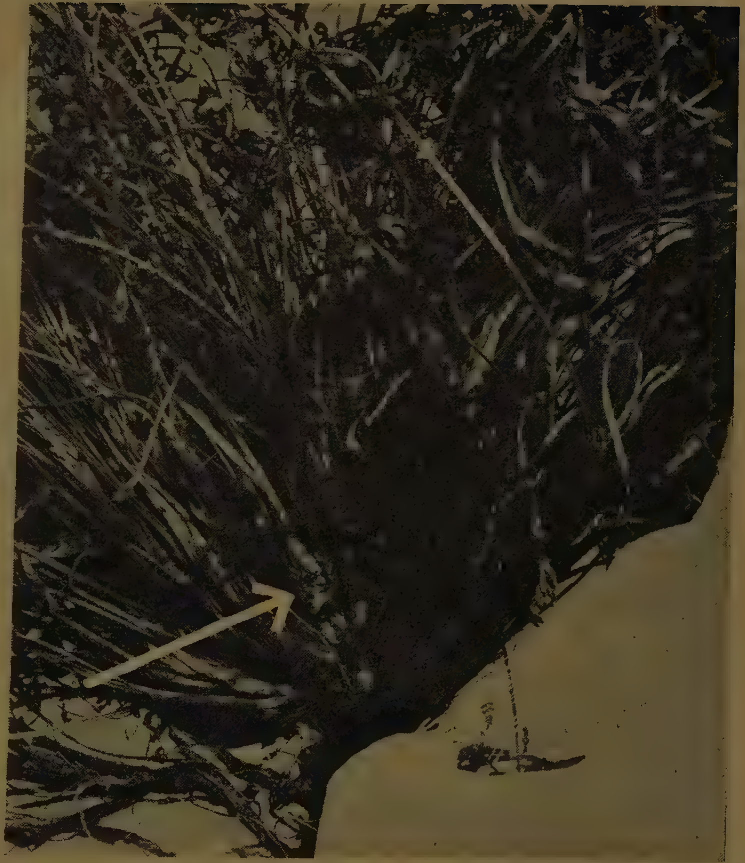

FIG. 1.—Portion of pyrethrum crown attacked by *Sclerotinia minor*. The arrow points to developing sclerotia. The foliage has wilted.

FIG. 2

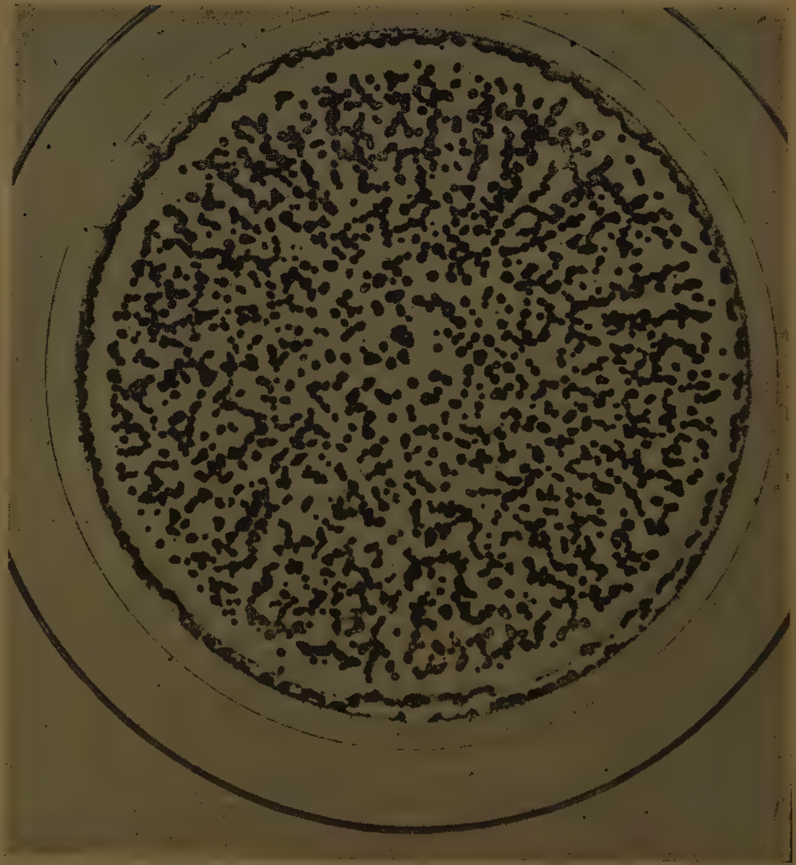

FIG. 2.—A culture of the fungus showing the development of the small sclerotia.

FIG. 3

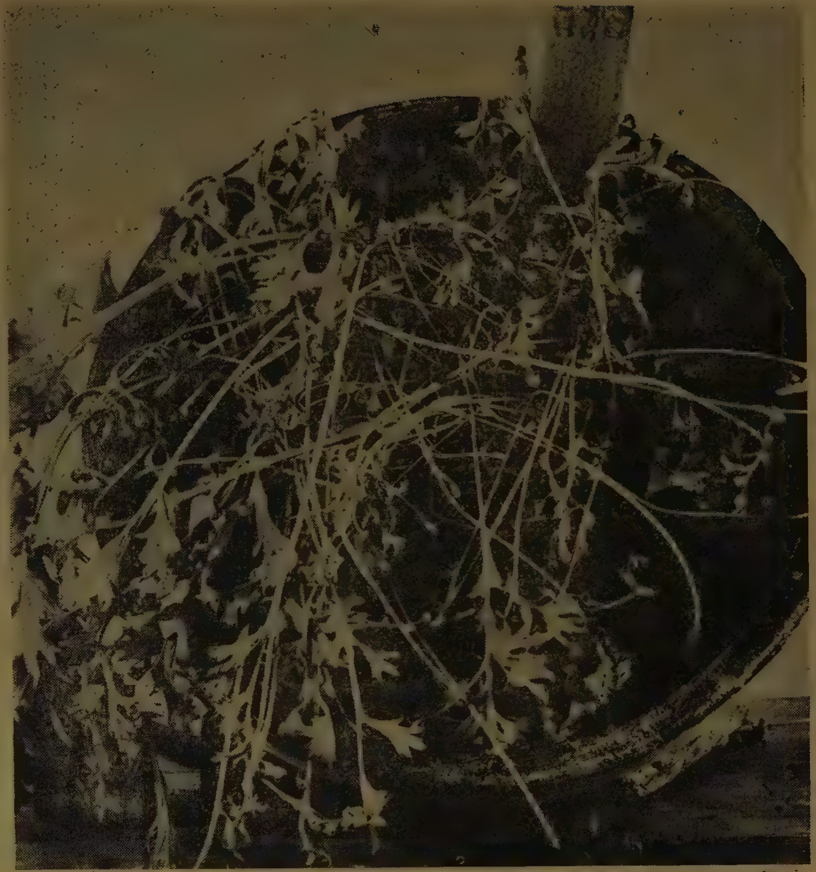

FIG. 3.—A wilted pyrethrum plant, six week after placing a small piece of an agar culture of the fungus about $\frac{1}{2}$-in. from the crown just below the soil level.

FIG. 4

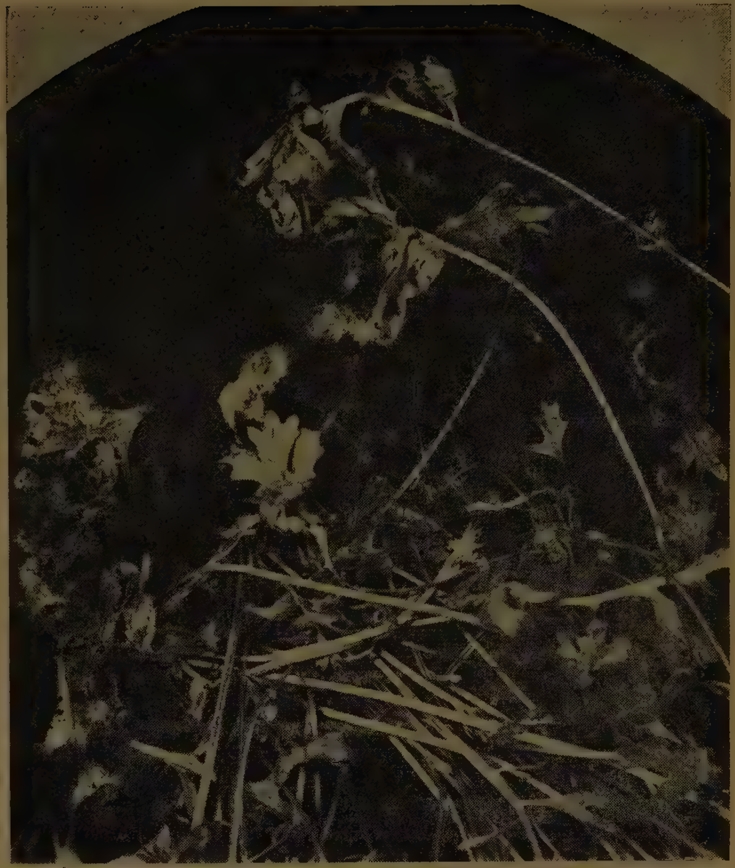

FIG. 4.—The same plant two days later, showing complete collapse and mycelium of the fungus spreading over the surface of the soil and beginning to form sclerotia.

THE PREPARATION OF NURSERY BEDS AND THE SOWING OF COFFEE SEED

By L. M. Fernie, Coffee Research Station, Lyamungu, Moshi, Tanganyika Territory

(*Received for publication on 18th March, 1950*)

Every endeavour should be made to give coffee plants a good start in life. The first step in achieving this aim is by careful attention to the preparation of the seed beds, and to the sowing of the seed and subsequent care of the young plants.

Site.—The site for the nursery should be selected on level or gently sloping ground, and should be sheltered from the prevailing wind. If any existing trees are retained as shade they will keep the air cooler and the humidity higher during the heat of the day, but their great disadvantage is causing drip from the leaves and branches during the rainy season. In any case, artificial shading of the seed beds will be necessary.

It is essential for an adequate and permanent supply of water to be available at the nursery, and this factor will, in many cases, limit the choice of site.

Soil.—The soil should be a good deep friable loam with a high humus content, easy to work, and capable of being broken down into a fine tilth. Adequate drainage is essential, and any site liable to waterlogging during the rainy season should be avoided, unless efficient drains can be dug above and to the sides of the area.

Seed Beds.—A convenient width for the seed beds is four feet, leaving an adequate path, about three feet wide, between the beds; this allows for easy movement of the nursery workers while watering and weeding, etc. The length of the beds will be determined largely by the site and the slope of the ground, but 24 to 30 feet is a convenient length, allowing for easy access to all beds. The beds should be made up across the slope of the land, and if the slope it at all pronounced, they are best made up on the contour.

When preparing the seed beds, all weeds, stones, roots and rubbish should be carried off and the area dug over thoroughly. Particular care should be taken to eradicate any pernicious perennial weeds such as couch grass. Well-rotted manure or compost may be incorporated in the soil, and the whole area reduced to a fine tilth.

After marking out the beds and paths, the top few inches of soil from the paths are thrown up on to the beds, which thus become raised a few inches above the level of the paths. These latter can be used as drains to lead away any excess water during the rainy season. The main drains should be marked out beforehand, so that any excess water can be led away safely, and under control, to an area with a permanent cover. If necessary, these drains should be stoned. The paths between the beds must be continuous and sloping gently towards the main drains.

The beds are then raked level and a fine even tilth obtained. During the dry season, a raised rim around the outside of the bed will prevent run-off of water.

Once made up, the beds should be watered regularly and the ensuing crop of weeds removed before seed sowing is attempted.

Seed Sowing.—In a four-feet wide seed bed as described above, six rows of seeds may be conveniently sown, the rows being six inches apart, leaving nine inches from the outside rows to the edges of the bed. These distances should be pegged at the ends of the beds, and the rows can then be marked out by holding a string against opposite pegs from end to end of the bed and working it backwards and forwards into the soil with a sawing motion. The seed, which should be specially selected and hand-picked, is then sown at from four to six inches apart in these rows at a depth of from ½ to ¾ inch only, no deeper. Slow or poor germination may often be attributed to excessively deep sowing. Experiments at the Coffee Research Station indicate that it is a sound practice to sow the seed flat side downwards.

Immediately after sowing, the whole bed should be watered again, and then mulched with banana trash, guinea grass, thatching grass or similar material. At the same time, during the dry season, artificial shade should be erected four feet above the beds. Palm leaves, if available, provide suitable material for this purpose; otherwise, the same materials as are used for mulching could be utilized here.

When a large nursery is being prepared, it might be easier to erect the artificial shade about six feet high to cover the whole area, including paths, thus allowing workers freedom of movement underneath. In this case, the paths could be somewhat narrower than as recommended above.

Germination.—The time required for the seed to germinate is normally from six to eight weeks, but will vary according to the age of the seed, the depth of sowing, and the time of year at which the seed is sown. Seed which is sown in February and which was collected from the previous crop, will be moderately fresh and should germinate fairly rapidly in the warm weather prevailing at that time, provided that regular watering is carried out and the beds are not allowed to dry out.

After Care.—Once the seedlings begin to push through the soil, the mulch should be carefully removed, and more frequent waterings will then probably be necessary. The artificial shade should be examined thoroughly at this time and any deficiencies made good. Once the rows are discernible, careful hand-weeding should be carried out, and the soil between the rows carefully loosened with a pointed stick or small hand-fork.

When the first pair of true leaves have appeared on the majority of the seedlings, mulch may again be spread, this time between the rows. Guinea grass, with its long thin leaves and stems, is very suitable for this purpose and does not tend to smother the young plants. By this means, moisture is conserved, the soil is kept cool, and weed growth is suppressed.

As the seedlings develop, all weaklings and "runts" are rogued out, only strong sturdy young plants being allowed to remain in the beds. Up to 50 per cent rogueing may be carried out, even when selected seed has been used.

The overhead shade is also reduced as the plants develop so that they may be hardened off, and not become too drawn up and spindly. If very hot weather prevails later in the year, it may be necessary to renew a light shade over all nursery beds.

Summary.—The nursery should be sited in a sheltered position on level or gently sloping ground, near to a permanent water supply.

The soil should be a good deep rich friable loam and well drained.

A convenient size for seed beds is four feet wide and 24 to 30 feet long, with paths three feet wide between the beds.

The seed is sown flat side downwards, ½ to ¾ inch deep in rows six inches apart, the seeds being spaced four to six inches in the rows.

Immediately after sowing, the bed is watered, and then mulched. Artificial shade is erected four feet above the bed.

Germination is normally from six to eight weeks, but varies according to the age of seed, depth of sowing, and season.

The mulch is removed when germination is apparent, but is renewed later when the first true pair of leaves have formed. The soil should be loosened and weeds removed as soon as rows are discernible.

Rigorous rogueing (up to 50 per cent) should be carried out, and only the best plants allowed to remain in the beds.

Careful attention must be paid to watering and shading.

TUNG OIL IN NYASALAND

As new plantings come into bearing, tung oil from the seeds of *Aleurites montana* increases in commercial importance in Nyasaland. At present only one factory is in operation but plans have been prepared for a second factory, both in the Southern Province while extensive plantings in the Northern Province will necessitate at least a third factory.

During the 1948/49 season, an investigation was made at the existing factory in order to determine—

(*a*) the optimum operating conditions for maximum efficiency of extraction;

(*b*) the analytical data of commercially produced tung oil (*montana*);

(*c*) whether analytical data of tung oil was affected by heating for facilitating separation of sludge.

The nuts were found to contain 60 per cent kernel, of oil content 64.4 per cent, equivalent to 38.6 per cent of oil in the whole nut. Pretreatment of the nuts presented difficulties in that the presence of little or no shell in the meal caused the machine to clog while too much shell caused excessive abrasion and yet the proportion of shell could not be adjusted with precision.

Decortication and winnowing were followed by grinding, steam digestion, continuous screw expelling and initial separation of foots by baffles in the oil discharge conduit. Final separation from sludge was effected in settling tanks.

Operating conditions on a number of occasions when factory temperature varied from 68° F. to 86° F. and humidity from 45 to 98 per cent were correlated with analytical data and the following conclusions were reached.

Theoretical yield based on the whole nut varied from 29.7 to 33.7 per cent of which approximately nine-tenths was actually recovered. Maximum oil yield was obtained generally when humidity was 69 per cent or less. When humidity was above 69 per cent an oil yield approaching 33 per cent was obtained only when the proportion of coarse particles in the meal was reduced and the proportion of shell in the meal increased to 32 per cent. When humidity was low a maximum of 21 per cent of shell in the meal was sufficient for maximum oil yield. Variation in the proportions of shell was the principal factor affecting the oil content of the press cake which varied from 6.3 to 13 per cent. The presence of toxic matter renders tung press cake unsuitable as a stock feed.

The oil produced was consistent in composition and in many respects, more especially at the beginning of the season, of quality superior to the requirements of the Standard Specification (391 : 1949). Separation of sludge from hot oil was more effective than the existing method of rapid cooling by running freshly made oil into a tank of cold oil. The heating required to effect improved separation had no deleterious effects upon the quality of the oil.

[Abridged from an article entitled: "Commercial Production of Tung Oil in Nyasaland—Technical Aspects." By V. R. Greenstreet, Agricultural Chemist, Nyasaland. In *Oil and Colour Trades Journal*, 116, 1765 (1949).]

BOOK REVIEW

NOTES ON ESTATE FORESTRY, By N. D. G. James (1949). Basil Blackwood, Oxford (vii + 75), 3/6d. net.

These notes which appeared as a series of contributions to the Journal of the Land Agents Society in 1947 and 1948 under the title of "Forestry Notes" are intended to give practical information in a concise form to those connected with estate forestry in England. They are almost non-technical and should interest landowners and land agents as well as the practical foresters.

The 13 chapters cover a wide range of subjects but the primary emphasis of the book is on how to plan, lay out and produce timber and fuel plantations at the smallest cost. This question of the importance of keeping down initial costs is not always realized, particularly when one is thinking in terms of timber maturing say a century hence.

The author has included an excellent chapter on "Forestry and Shooting", a very controversial subject, which could profitably be read by all connected with forests, farms, game and national parks in East Africa. In dealing with this question the author rightly says " . . .with tact and appreciation of the requirements of both gamekeeper and forester there is no reason why a satisfactory solution should not be found".

Other important chapters deal with a calendar of work to be carried out month by month not only in the woods but also in the nursery. Lack of such a programme has led to the failure of many plantations.

If one may presume to criticize such an excellent production it is to suggest that in the chapter on Seed Collection more emphasis might have been laid on the vital importance of using only the best seed of the best strain of the most suitable species. Mistakes or carelessness in seed collection may not be apparent in their results for many years.

This little book is well produced, it is concise and readable and moderately priced. It is a worthy successor to "Working Plan for Estate Woodlands" which was another valuable contribution by Mr. James to the literature on private forestry in England.

A.L.G.

POULTRY-KILLING AND PROCESSING

By Alfred Ginsberg, Department of Veterinary Services, Kenya

(*Received for publication on 29th March,* 1950)

The meat of poultry forms a large proportion of man's diet and ranks next to the flesh of mammalia. Considerable quantities of birds are exported to Britain by France, Ireland, Poland, Italy, etc. The poultry industry of this Colony is developing and the time may not be far ahead when the number of birds will far exceed local demands and leave a substantial quota for export. To compete, however, with the old established continental exporters everything will have to be done to satisfy the standard demands of the British market. Besides choosing the proper breeds, methods of feeding, slaughtering, processing, sorting and plucking have to receive very careful attention if a standard product is desired.

Before killing, the birds, similarly to other animals should be kept without food for 12 to 18 hours. To avoid shrinkage water should be given in plenty and it is advisable to keep the fowls in a comfortable place which is neither excessively hot nor cold. The rest and starving period is important and should not be abandoned under any circumstances as the birds keep much better after slaughter and the grey or green appearance of the skin is generally avoided.

The methods of killing differ; the majority of birds in Britain are slaughtered by dislocation or wringing the neck. The United States of America and the Continent prefer sticking the bird's neck from inside or outside with a special knife which has a narrow blade about ¼ in. to ⅜ in. across, with a very sharp point. The length of the sticking knife varies from three to five inches. To reduce struggling the birds are hung on their hock joint or placed in a special killing funnel.

The importance of proper bleeding cannot be over-emphasized as, beyond any doubt it improves the appearance of the carcass and gives the flesh the desired whitish colour. Improper bleeding on the other hand does not only reduce the resistance and durabiliy of the carcass but its quality as well, as the flesh loses its firmness, rapidly decomposes and becomes stale or develops an abnormal odour.

Plucking is the next of the dressing operations. It is done while the flesh is still warm or by the quicker method used nowadays, i.e. scalding combined with a plucking machine.

Although scalding is a substantial time saver, it may do a lot of harm to the carcasses if not properly carried out. It should take place immediately the bird ceases struggling and bleeding and it is advisable to move the fowl about in the scalding vat. A careful check must be kept on the temperature of the water which should be maintained between 125° F. to 129° F. for chickens and turkeys. The time required is about half to one minute depending of course upon the age of the bird. Too high a temperature may easily give bad results such as loss of bloom or even black spots on the skin after chilling. Ducks and geese require a higher temperature (between 175° F. to 190° F.).

The plucking of the bird should take place about half a minute after scalding. The plucking machine works on similar lines to the mechanical pig scraper. It has rubber fingers attached to a central shaft moved by an electromotor. The feathers are removed by the friction of the rotating rubber fingers and deposited at the bottom of the machine. The mechanical plucker is most suitable for large production as a medium-sized one can handle 125 to 150 chickens or turkeys per hour.

The singeing of the bird should be carried out after all the pin feathers have been removed otherwise dark spots may spoil the appearance of the carcass.

With regard to evisceration, opinions vary, as many consider that undrawn fowls show less contamination of the flesh and therefore have a better keeping quality, whilst other poultry industrialists prefer fowls which are partially drawn or completely eviscerated. Whatever method is adopted the dressing has to be carried out very carefully and strictly in keeping with the demands of hygiene. If undrawn frozen birds are defrosted, evisceration has to be carried out as soon as possible as otherwise discoloration of the abdomen may result. As regards export of birds the regulations of most countries, not excluding Britain, now demand complete evisceration and removal of head and legs to avoid the spread of any disease communicable to other fowls.

The cooling of the carcass may be done by soaking the bird in cold water or by the more up-to-date method of transferring the carcass to a cold store. Four to six hours of cooling is usually sufficient to penetrate the entire carcass if the temperature is 33° F. and the humidity not less than 85 per cent. The high percentage of moisture is necessary to maintain the flesh and appetizing appearance of the carcass as well as to minimize shrinkage.

Poultry, similar to other food animals, require careful handling, especially before slaughter, as any bruising reduces the quality and durability of the carcass or even renders it unfit for human consumption. Torn skin due to bad plucking or overscalding is another fault which should be avoided if a standard production is desired.

In the slaughter of food animals full use of all by-products means substantial revenue. Where only a few birds are killed, little can be gained by the utilization of the by-products. However, where a considerable quantity of poultry is dealt with the by-products become as important a branch as in the slaughter of cattle or pigs. Full use can be made of the fat covering the intestines and internal organs. A substantial amount of fat can also be obtained by rendering the heads. Feathers are much in demand especially from geese and ducks. The giblets, similar to the plucks of slaughter animals, find a ready market and are mainly purchased by hotels and restaurants. If large amounts are available pastes are produced and canned.

The sufficiently cooled birds are packed in greaseproof paper and each consignment must strictly comply with the standards laid down by the importing country.

As in the slaughter of food animals, hygiene, proper equipment and careful handling are the main items on which a successful operation depends. A complete slaughter arrangement with killing and dressing departments similar to that for cattle or pigs is essential if large numbers of birds are killed and processed.

CROSSROADS

There is some danger that the present spate of writing on the dangers which threaten humanity through soil exhaustion and loss may defeat its own object. That is to say, that humanity will come to regard its end as inevitable and will become impatient with constant reference to it. Indeed there are many signs that this has already begun to happen. Man has invented many a fiction and euphemism to soften a little the hard fact of his own individual mortality and, rightly, will not tolerate a dismal jimmy who constantly harps on the unpleasant fact. Constant reference to man's mortality in fact is only countenanced when adequate service is also paid to man's immortality.

If the extinction of humanity were also inevitable the right gesture would certainly be a shrug of the shoulders. It is the opinion of Mr. William Vogt* and of many soil workers that the end is not inevitable but that mankind stands now at the crossroads and it is for our deliberate choice whether the turning we take is the road to survival or the road to extinction.

A century and a half ago the "gloomy curate" Malthus prophesied that increasing population would soon outstrip food production. (That we have lived another 150 years has been taken by some as a refutation of Malthus.) But what not even Malthus foresaw, or could foresee, was that in increased production itself would lie the germ that threatened humanity's future.

Man has not, at least for the period of his recorded history, accepted his environment. He has struggled against it and has often managed to change it. But in doing so he has, in Vogt's striking phrase, increased the "environmental resistance" to his struggles. Mr. Vogt draws the inescapable conclusion that it is not by blind struggling that man will now survive, but by a planned effort based on a thorough understanding of the evironmental factors and of his own place as a link in the chain of living things.

Mr. Vogt is no fanatical mystic. As chief of the Conservation Section of the Pan-American Union he has his feet on the ground and when he quotes that "the really productive areas of the world are so limited that there is only about two-tenths of an acre per person" we must stop and think, and not stop too long. Man's best brains must be enlisted into agriculture, not only into agricultural "departments" but into farming itself. Farmers have rightly prided themselves on being practical men, but foremost among the professions they have deserved the gibe that a practical man is one who works on the theories of 50 years ago.

G. AP G.

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* "The Road to Survival", William J. Vogt, Gollancz, 15s., pp. 288, with 55 pages of bibliography and index.

A NOTE ON THE RELEASE OF SOME NEW CEREAL VARIETIES—II

By H. C. Thorpe, Senior Plant Breeder, Department of Agriculture, Kenya

(*Received for publication on 29th April,* 1950)

The following cereal varieties have been released to farmers from departmental control for sowing in 1950. All have been tested firstly in small trial plots and then on a field scale with farmers in various parts of the Colony and have been released through normal channels, i.e. The Kenya Farmers' Association (Co-op.), Ltd. Fuller details of the procedure adopted were given in an earlier article. [1]

Kenya Settler—Wheat No. 294.*M*.7.*C*.1.*C*.

A selection out of the cross Australian 26.A. × 117.A., bred and selected at Njoro.

It is a beardless, white-chaffed, white-grained wheat possessing fair straw strength and medium length maturity, equal roughly to 117.A., and taking approximately 5¼ to 5½ months at Njoro, 7,100 feet. It has full resistance to the eight biologic forms of black stem rust occurring in the Colony, possesses appreciable resistance to leaf rust and is resistant to yellow ear rust up to 8,000 feet in Kenya.

This wheat is similar to 294.M.7.C.6.A., out of the same cross and released in 1948, and is a week to ten days later in maturity. It has done well in large-scale trials in the Solai area of Kenya and should be suited to all areas in the Colony in which 294.M.7.C.6.A. is successful, i.e. 6,000 to 8,000 feet approximately having a growing season of five to six months' duration.

Kenya Ploughman—Wheat No. 318.*O*.3.*B*.2

A selection out of the cross D.C. by Ceres 721 × 112.E.8.L.5, bred and selected at Njoro.

It is a beardless, white-chaffed, white-grained wheat of fair straw strength, maturing in approximately 5¾ to 6 months at Njoro, 7,100 feet. It has full resistance to the eight biologic forms of black stem rust occurring in the Colony, is fairly resistant to leaf rust and to yellow rust up to approximately 8,500 feet in Kenya.

This wheat is similar to 318.AJ.4.A.1, out of the same cross and released in 1948, but is suited to slightly higher areas. It has done well in the Ol Kalou and Ol Joro Orok areas of Kenya and should be suited to all areas in the Colony from 7,500 to 8,500 feet having a growing season of six months' duration.

291.*J. Mark II*

A single plant selection from 291.J.1.I.1, made to purify the variety. It has straw strength, maturity and grain quality equal to the parent strain and is suitable for all areas in Kenya in which 291.J.1.I.1 grows successfully, i.e. from 6,000 to 7,000 feet.

This selection should provide a source of pure seed for farmers wishing to renew their stocks of this variety.

Canadian Mariout Barley

This Canadian barley is a six-row feeding variety of good straw strength and yield. It matures in approximately 4½ months at Rongai, 6,000 feet.

It has done well in large-scale field trials in the Rongai and Solai areas of Kenya and should be suitable for all areas in the Colony from 5,000 to 6,500 feet having a growing season of four to five months' duration.

Canadian Mariout is somewhat uneven and consists of a mixture of two six-row types, one with an erect head and one with a dependent head. This may be due to mixture in the original importation. Work is going on to purify the variety; but in the meantime it has been decided to release Mariout in view of its good field performance in the areas mentioned. A more even selection may be issued at a later date if the variety continues to yield satisfactorily on a field scale.

Black stem rust = *Puccinia graminis tritici.*

Leaf rust = *Puccinia triticina* (*Eriks.*).

Yellow ear rust = *Puccinia glumarum* (Eriks. and Henn.).

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[1] Thorpe, H. C. (1949), "A Note on the Release of some New Cereal Varieties". *E.A. Agric. J.*, XIV, pp. 210-211.

BOOK REVIEW

The Theory of Inbreeding, By R. A. Fisher, published by Macmillan & Co., London. Price 10/6d.

This new book by Professor Fisher will probably become to the research worker in plant and animal breeding what his "Design of Experiments" is to the agronomist. Here in East Africa where the improvement of food crops and the improvement of cattle are vital problems the book will be particularly useful.

While it is pointed out that in general inbred stocks will themselves be unprofitable, the importance of maintaining segregating inbred lines for the pure research is discussed. Without them controlled comparisons of certain genetic differences, which require at the same time the presence of the genes producing strictly comparable influences on the organic system, would be impossible. The preservation of living genetic material is best carried out by inbreeding; genetic factors will then be ready for immediate use, and a rare gene may be preserved in an isolated stock, enabling it to be easily recovered for interbreeding or comparison purposes.

Inbred lines are conveniently carried on in a series of parallels, and the failure in any one can then be replaced by a mating with one of the others. The price paid for reliability of breeding behaviour is usually the impoverishment of the genic content, but if a deliberately planned set of lines is used there need be no impoverishment.

Inbred lines kept segregating for several factors ensure a steady supply of data on possible linkages, and sets of lines may be used for a survey of the linkages of a number of apparently independent factors. As an example a comprehensive design is suggested for testing 21 factors in mice in a series of parallel lines each segregating in five factors.

The main reason for inbreeding is to obtain stock giving reliable breeding behaviour; the main body of the book (Chapters III and IV) is therefore devoted to a discussion of the measurement of the progress towards homozygosity of different mating systems. Attention is confined initially to a single locus, and the different types of mating are enumerated. Assuming a sib-mating system the probabilities of the different mating types resulting from these initial matings are given, and from this the generation matrix is formed. The process of finding the state of the population after n generations is explained in a simple manner which may be followed by those of us who have no particular bent for mathematics.

A measure of the progress to homozygosity is defined enabling different systems of inbreeding to be compared. This measure may be used to determine the delay in progress caused by the introduction of any irregularity in the system. It is shown, in particular, that a system of sib-matings is equally efficient in tending to homozygosity with a system of parent-offspring matings. In addition the introduction of a parent-offspring mating in the former retards progress to exactly the same extent as a sib-mating introduced into the latter. Various other systems of inbreeding are discussed on a similar basis. In particular a scheme is suggested whereby a region of the sex-chromosome carrying an important character may be rendered homogeneous relatively rapidly; this is particularly useful with animals such as dairy cattle.

During most of the discussions several offspring at birth have been implicit in the argument, but an appendix is devoted to a consideration of species having only one offspring at each birth. The use of successive sib-matings is impracticable, and parent-offspring matings are to be preferred, but a mixture of the two systems is probably of more practical use, and certain schemes are discussed.

Another appendix discusses various mechanisms preventing self-fertilization among hermaphrodite plants, and their effects in lessening the probability of crosses between near relations. Yet another appendix gives a brief discussion of the function of inbreeding in the practical improvement of crops and livestock.

Throughout it is realized that there are attendant dangers, but with a properly planned programme of inbreeding, reliable breeding material is always at hand. The great practical value of inbred lines in agricultural development is as parent stock for crossbred combinations. This has been particularly successful in the production of "hybrid corn" in the United States. With all the evidence of improvement in crops more concentrated efforts should be increasingly made in the inbreeding of livestock.

Agricultural research in East Africa is still very young, and every opportunity should be made to begin on the correct lines of research. So much time is wasted at the beginning of most projects by not knowing the exact method of proceeding. This book affords every opportunity of stepping off on the right foot.

P. ROBINSON.

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